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Cambridge
Intermediate Mathematics

ARITHMETIC

PART I

With Answers

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Cambridge

Intermediate Mathematics

by
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ARITHMETIC

PART I

With Answers



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PREFACE

The Cambridge Intermediate Mathematics series, consisting of text-books in Arithmetic, Algebra and Geometry, each in two parts, has been designed to meet the needs of pupils in the newly organised Modern Schools and Senior Classes recommended by the Hadow Report.

“The first work of teachers and administrators is,” to use the words of *The New Prospect in Education*, just published by the Board of Education, “to think out their goal, feeling their way towards an appropriate curriculum.” It is impossible to predict with any certainty the form which the curriculum will ultimately take; indeed, it is improbable that any such limitations as are imposed upon the Secondary School can ever be applied to the diversified types of senior schools which are about to spring up. But probably all are agreed that these schools must not become “an anacenic reflection of the present Secondary School.”

ARITHMETIC, PART I is intended to provide a complete course in arithmetic for the average non-selective senior school. Whilst not based on the syllabuses of existing examining bodies, it will probably be found to cover the requirements of any examination which pupils in these schools are likely to take. This book, with PART II, should supply all that is required for a pass in the usual School Certificate examinations, or for any Central School Certificate examination which may later be instituted. In addition, these books will be suitable for use in Evening Institutes.

It will be noticed that most of the exercises in PART I are in three sections, (a), (b) and (c). The answers to questions in section (a) are intended to be written down without any working on paper by the brighter pupils, and with the minimum of working by the others. The exercises in section (b) are of a more or less mechanical nature, whilst those in section (c) consist of applications of the rules learnt. This feature should make the book particularly useful in the ordinary senior school, even for pupils

on the "slow side"; there is ample material for all grades of intelligence, and even the brighter pupils may, with advantage, be required to work a proportion of each section. A further feature, which will be found in all the books of this series, is the interpolation of series of sectional revision exercises, which will enable the teacher to ensure that the back work is not forgotten.

For permission to make use of examples from numerous examination papers and to reprint others in full, I am indebted to the courtesy of the Oxford Local Examinations Delegacy, the Cambridge Local Examinations Syndicate, the Examinations Board of the National Union of Teachers, the Royal Society of Arts, the London Chamber of Commerce, the East Midland Educational Union (E.M.E.U.), the Union of Educational Institutions and the Union of Lancashire and Cheshire Institutes. Special attention is directed to the first papers set in the Royal Society of Arts Junior Schools Certificate Examination and in the E.M.E.U. Central Schools Examinations, both instituted in 1927; copies of these papers will be found at the end of the book. I am also indebted to Mr. A. C. P. Handover for his invaluable assistance in obtaining solutions to the numerous examples.

H. J. L.

September 1928

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ARITHMETIC

REVISION OF THE FOUR RULES—NUMBER

1. Notation.

The system of notation used in England, namely the *Arabic* system, consists in the use of the 10 symbols or DIGITS 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

The value of each digit is fixed by means of its position with respect to the UNIT, each digit having a value ten times as great as that of the same digit one place to the right, and one-tenth of that of the same digit one place to the left; e.g.

Hundreds	Tens	Units
1	1	1

1 hundred is 10 times 1 ten; 1 ten is 10 times 1 unit. In the same way 5 hundreds are 10 times 5 tens; 5 tens are ten times 5 units.

The expression of large numbers in words or in figures will present no difficulty if it is realised that just as there are units, tens of units and hundreds of units, so there are units of thousands, tens of thousands and hundreds of thousands, and also units of millions, tens of millions and hundreds of millions.

Take the number 513964872, which uses 9 of the 10 digits. These can be divided, and often are so divided, into groups of three figures by means of commas, starting from the right:

513,964,872.

Here we have:

	H.	T.	U.	
<i>Millions</i> group	5	1	3	H. T. and U. of Millions
<i>Thousands</i> group	9	6	4	H. T. and U. of Thousands
<i>Units</i> group	8	7	2	H. T. and Units.

Ex. 1. Write in words 19870005.

Divide into groups by commas; 19,870,005.

The three groups are:

19 millions
870 thousands
5 units.

The number is, therefore, nineteen million eight hundred and seventy thousand and five.

Ex. 2. Write in figures eighty million two hundred and six thousand and seventeen.

The three groups are:

80 millions
206 thousands
17 units.

And since the thousands and units groups must be complete, each with three figures arranged according to place value, we get:

80,206,017.

2. The Roman System.

In the *Roman* system the first ten numbers are written as follows: I, II, III, IV, V, VI, VII, VIII, IX, X.

Numbers from 11 to 20 are formed by placing x in front of the above numerals: XI, XII, XIII, XIV, etc.

In the same way numbers from 21 to 29 are formed by prefixing xx, and those from 31 to 39 by prefixing xxx.

40, 50, 60, etc. are written in the forms:

XL, L, LX, LXX, LXXX, XC, C;

41 to 49, 51 to 59, etc., by placing these before the numerals I to IX, and 200, 300, 400, etc. in the forms:

CC, CCC, CD, D, DC, DCC, DCCC, CM, M.

On examination of the above it will be seen that

- (a) I placed before v or x signifies that 1 is to be taken from 5 or 10;
- (b) x placed before L or C that 10 is to be taken from 50 or 100;
- (c) and c placed before D or M that 100 is to be taken from 500 or 1000.

Ex. 1. Write in Roman numerals the date 1739.

Here we have 1000, 500, 200, 30, 9.

∴ MDCCLXXXIX.

Ex. 2. Write in the ordinary notation MDCVIII.

M = 1000, D = 500, C = 100, VIII = 8.

∴ 1608.

3. Addition.

Hints for the addition of long columns and rows:

1. Test answers by adding from top to bottom as well as from bottom to top, or from left to right as well as from right to left.
2. Careful arrangement of columns according to place value will help to avoid confusion.
3. When long columns are being added it may be advisable to write down the carrying figure as a check in revision.

4. Subtraction. *Complementary Addition*, or the "Shop" Method.

$$\begin{array}{r} 59,200 \\ 38,764 \\ \hline 20,436 \end{array}$$

It may be a good plan to practise the complementary addition method, since it is the method always used in giving change.

Here we say:

- 4 and 6 make 10. Put down 6 and "carry" 1.
 7 and 3 make 10. Put down 3 and "carry" 1.
 8 and 4 make 12. Put down 4 and "carry" 1.
 9 and 0 make 9. Put down 0. There is no carrying figure.
 3 and 2 make 5. Put down 2.

The various complementary additions are emphasised in the mind whilst writing them down.

5. Multiplication.

$$5678 \times 275.$$

Always multiply by the figure of highest value first.

5678	or	5678
275		275
<u>1135600</u>		<u>11356</u>
397460		39746
28390		28390
<u>1561450</u>		<u>1561450</u>

6. Division.Ex. 1. $562875 \div 1408$

$$\begin{array}{r}
 399 \\
 1408 \overline{)562875} \\
 \underline{4224} \\
 14047 \\
 \underline{12672} \\
 13755 \\
 \underline{12672} \\
 1083
 \end{array}$$

Answer 399, and 1083 over
 or 399, remainder 1083
 or $399\frac{1083}{1408}$.

Note: 1408 must be divided into 5628 and the *partial quotient* is 3. Place the 3 over the last of these figures. It will then be clear that two other figures must follow in the quotient.

Ex. 2. $841825 \div 276$

$$\begin{array}{r}
 3050 \\
 276 \overline{)841825} \\
 \underline{828} \\
 1382 \\
 \underline{1380} \\
 25
 \end{array}$$

Answer $3050\frac{25}{276}$.

Note: Placing the 3 of the quotient over the 1 indicates that there will be three other figures in the quotient. 138 is not divisible by 276 and hence a 0 must be put over the 8. Similarly we place a 0 over the 5.

Ex. 3. Find the average of 86, 72, 105, 0, 73.

$$\text{Total} = 336$$

$$\text{No. of terms} = 5$$

$$\text{Average} = 67\frac{1}{5}.$$

7. Short Methods, etc.

- (a) To multiply by 25 add two 0's and divide by 4, since $25 = 100 \div 4$. To multiply by 125 add three 0's and divide by 8.
- (b) To divide by 25 multiply the number by 4 and divide by 100. To divide by 125 multiply by 8 and divide by 1000.

- (c) A number is divisible by 3 or 9 respectively if the sum of the digits is divisible by 3 or 9.
- (d) A number is divisible by 4 if the number composed of the last two digits is divisible by 4, and by 8 if the number composed of the last three digits is divisible by 8.
- (e) Note that $(25)^2$ or 25^2 means 25×25 ; $(17)^3 = 17 \times 17 \times 17$ etc.

EXERCISE 1 (a). MENTAL.

Write in figures:

1. Two hundred and four thousand one hundred and sixteen.
2. Three hundred and ten thousand and sixty-four.
3. One hundred and eighteen thousand seven hundred.
4. Two million four hundred thousand and sixteen.
5. Forty-five million seventy thousand and fifty-six.

Express in words:

- | | | |
|----------------|------------------|---------------|
| 6. 25,018. | 7. 460,308. | 8. 1,256,304. |
| 9. 50,506,040. | 10. 279,260,305. | |

Write in ordinary notation:

- | | | |
|------------|----------------|---------------|
| 11. XIX. | 12. XVIII. | 13. CXXVI. |
| 14. CCXXI. | 15. XLIV. | 16. MDCCCXIV. |
| 17. MCXL. | 18. MDCXXVIII. | |

Write down the answers to:

- | | | |
|---|-------------------------|--------------------------|
| 19. $2516 + 364 + 2706 + 85,006 + 9$. | | |
| 20. $25,184 + 15,060 + 179,054 + 4685$. | | |
| 21. $50,016 - 47,018$. | 22. $30,000 - 15,183$. | |
| 23. $20,000 - (564 + 15,168 + 1675 + 83)$. | | |
| 24. 5687×9 . | 25. $72,364 \times 8$. | 26. $50,057 \times 11$. |
| 27. $5438 \div 8$. | 28. $37,062 \div 12$. | 29. $56,157 \div 5$. |
| 30. 364×25 . | 31. 5613×25 . | 32. 257×125 . |
| 33. 564×125 . | 34. $13,250 \div 25$. | 35. $13,375 \div 125$. |

36. Is the number 567,156 divisible by 3, 4, 8, 9? Write "yes" or "no" for each divisor.

EXERCISE 1 (b).

Add the following:

1. 3,564,207	2. 5,786,302	3. 47,385
45,169	56,192	9
9,387	567,348	1,579
46	99	357,168
2,786	158	4,732
<u>103,572</u>	<u>67,365</u>	<u>5,487,329</u>
4. 563,187	5. 2,837,694	6. 56
8,509	578,365	279
56,549	4,392,807	35,397
1,576,529	903,593	259,406
87,328	85,467	85
<u>7,497</u>	<u>937</u>	<u>5,369,587</u>

Subtract:

7. 50,408	8. 148,302	9. 408,004
<u>27,397</u>	<u>79,197</u>	<u>29,759</u>
10. 203,203	11. 1,202,367	12. 3,000,000
<u>106,706</u>	<u>857,469</u>	<u>1,287,209</u>
13. 5643×207 .	14. 2705×350 .	15. 4792×187
16. $2853 \times 7 \times 6 \times 5$.	17. $5 \times 3 \times 9 \times 4615$.	18. 7564×1009 .
19. $92,875 \div 331$.	20. $412,008 \div 732$.	21. $307,064 \div 139$.
22. $1,596,854 \div 38,672$.	23. $2,512,375 \div 7625$.	
24. $3,872,000 \div 55,105$.	25. $8,236,709 \div 85,496$.	

EXERCISE 1 (c).

1. How long, to the nearest minute, would it take for 21,156 people to pass the turnstiles of a football field, if each of 16 turnstiles admits 53 a minute?

2. A book has 128 pages. Each page has, on an average, 35 lines, and the average number of words per line is 14. How many words are there in the book?

3. How many minutes are there in a leap year?

4. By how much is thirty-five thousand two hundred and five short of a quarter of a million?

5. Which is greater, and by how much, the cube of 37 or the square of 242? [$37^3 = 37 \times 37 \times 37$; $242^2 = 242 \times 242$.]

6. How many inches are there in a quarter of a mile?

7. In 1913 the total consumption of potatoes in the United Kingdom was $7\frac{1}{2}$ million tons. If the population was estimated at 46 million, find to the nearest pound the average number of pounds of potatoes consumed per head for the year.

8. What number is as much greater than 136,594 as 598,142 is less than 739,475?

9. In a certain year the population of a town was 135,000. During the next twelve months the birth-rate was 21 per thousand and the death-rate 13 per thousand. Estimate the population at the end of the twelve months.

10. Find to the nearest unit the result of dividing 473,265 by $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2$.

11. If $7!$, which is called factorial 7, means $7 \times 6 \times 5 \times 4 \times 3 \times 2$, find its value.

12. The analysis of a Bank's weekly returns for 4 weeks is as follows:

Date	Public deposits	Other deposits	Bank post bills	Total deposits and bank post bills
	£	£	£	£
17th Nov.	20,482,486	100,217,687	3135	120,703,308
24th Nov.	23,808,076	100,826,331	3316	124,637,723
1st Dec.	9,191,372	117,827,262	2234	<i>x</i>
8th Dec.	8,805,503	111,585,201	2253	<i>y</i>

Find the figures for the spaces marked *x* and *y*.

13. Find the average of £3,303,382, £3,792,206, £2,132,857, £1,756,993, £1,759,272.

14. A certain firm pays out £257 weekly and the average weekly takings are £513. What are the net profits for 10 years?

15. Divide £1,596,200 between three persons so that the first has £50,000 more than the second and the second £49,500 more than the third.

MONEY, REVISION OF THE FOUR RULES AND “REDUCTION”

8. Multiplication.

Ex. 1. £151. 17s. 5½d. × 463.

£	s.	d.	f.
151	17	5	2
			463
70317	3	2	2 or £70,317. 3s. 2½d.
404	212	231	926
46300	4630	2315	
23150	3241	2546	
463	8083		
70317			

Step 1. Multiply farthings by 463, i.e. 463×2 , or 926. Divide by 4 to bring to pence; 231d. and 2 farthings over. Put up 2 farthings in the answer line and 231 pence in the pence column below the line.

Step 2. Multiply 5d. by 463, i.e. 463×5 , or 2315. Put below 231 pence and add. Bring 2546 pence to shillings, put remainder 2 pence in the answer line and 212 shillings in the shillings column below the line.

Step 3. For the shillings column multiply 463 first by 10 and then by 7, and proceed as before, bringing up 3s. remainder to the answer line.

Step 4. For the £s column multiply 463 by 100, 50 and 1 in succession. Bring up the £s to the answer line.

9. Division—Sharing.

Ex. 2. £27,306. 15s. 2½d. ÷ 753.

£	s.	d.	f.
36	5	3	1
753)27306	15	2	2
2259	3960	2520	1052
4716	3975	2522	1054
4518	3765	2259	753
198	210	263	301

Answer. £36. 5s. 3¼d. Remainder 301 farthing.

10. Downward "Reduction."Ex. 3. Bring £153. 7s. $6\frac{1}{2}d.$ to half-pence.(a) *Ordinary Method.*

£	s.	d.
153	7	$6\frac{1}{2}$
<hr/>		
20		
<hr/>		
3067		
<hr/>		
12		
<hr/>		
36810		
<hr/>		
2		
<hr/>		
73621 half-pence.		

(b) *Column Method.*

£	s.	d.	hp.
153	7	6	1
<hr/>			
3060	36804	73620	
<hr/>			
3067	36810	73621	half-pence.

11. Upward "Reduction."

Ex. 4. Bring 29,765 farthings to £ s. d.

4	29765		
12	<hr/> 7441d. Rem. 1f.		
20	<hr/> 620s. Rem. 1d.	£31. 0s. $1\frac{1}{4}d.$	
<hr/> £31. Rem. 0s.			

12. Division—Measuring.Ex. 5. How many times is $10s. 6\frac{1}{2}d.$ contained in £21. 10s. 5d. and how much is left undivided?

£21. 10s. 5d.	10s. $6\frac{1}{2}d.$
<hr/> 20	<hr/> 12
430	126
<hr/> 12	<hr/> 2
5165	253 half-pence.
<hr/> 2	
10330 half-pence	
253)10330(40	
1012	
<hr/> 210	

40 times and 210 half-pence, or 8s. 9d. left undivided.

13. Subtraction. The "Shop" Method.

Ex. 6.	£	s.	d.	$\frac{3}{4}d.$ and $\frac{3}{4}d.$ make $1\frac{1}{2}d.$ Carry $1d.$
	15	7	$4\frac{1}{2}$	$6d.$ and $10d.$ make $1s. 4d.$ Carry $1s.$
	2	19	$5\frac{3}{4}$	$20s.$ and $7s.$ make $£1. 7s.$ Carry $£1.$
	£12	7	$10\frac{3}{4}$	3 and 12 make 15.

EXERCISE 2(a). MENTAL.

1. £3. 7s. 10d. + £1. 15s. $7\frac{1}{2}d.$ + £29. 13s. $7\frac{1}{4}d.$
2. £2501. 7s. $8\frac{1}{2}d.$ + £1426. 17s. $9\frac{1}{4}d.$ + 10s. $6\frac{3}{4}d.$
3. £501. 15s. $7\frac{1}{4}d.$ + £138. 14s. $11\frac{1}{2}d.$ + £95. 15s. $7\frac{3}{4}d.$
4. £2016. 12s. $7\frac{1}{2}d.$ + £1589. 13s. $9\frac{1}{4}d.$
5. £1000 - £49. 12s. $7\frac{1}{4}d.$
6. £52,105. 1s. 9d. - £29,468. 15s. 10d.
7. £15,104. 13s. 8d. - £2598. 15s. 9d.
8. £20,000 - £15,684. 17s. $9\frac{1}{2}d.$
9. £45. 17s. $6\frac{1}{2}d.$ × 8.
10. £201. 12s. $9\frac{1}{2}d.$ × 7.
11. £156. 15s. $10\frac{1}{4}d.$ × 9.
12. £3056. 17s. × 20.
13. 17s. $11\frac{3}{4}d.$ × 12.
14. £1. 3s. 4d. × 240.
15. 12s. $1\frac{3}{4}d.$ × 960.
16. £46. 15s. 9d. ÷ 6.
17. £251. 2s. 5d. ÷ 11.
18. £3405 ÷ 9.
19. £20,000 ÷ 7.
20. £1564. 12s. 7d. ÷ 20.
21. Bring 10s. $5\frac{1}{2}d.$ to pence.
22. 97 farthings to s. and d.
23. 279 shillings to £s and s.
24. 965 farthings to £ s. d.
25. 297 pence to £ s. d.
26. 2416 pence to £ s. d.
27. 165 pence to s. and d.
28. 86 farthings to s. and d.
29. 1s. $11\frac{3}{4}d.$ to farthings.
30. 19s. 11d. to pence.

EXERCISE 2 (b).

1. Add.	2. Add.	3. Subtract.
£ s. d.	£ s. d.	£ s. d.
25,162 13 5½	23,087 12 5½	3016 12 5½
8,086 12 6¼	62 3 10¼	879 11 5¾
885 5 2	4,837 14 9	
1,326 13 9¾	21,106 2 7¾	
42,856 18 8	85 17 11½	4. £ s. d.
9,308 0 3½	9 2 8	55,200 0 0
27 5 11	2,564 12 5½	17,651 18 5½
516 17 10¼	865 17 10¼	
1,369 2 8½	8 9 0	
72 12 0¾	12 9¾	5. £ s. d.
		50,000 2 1½
		48,760 12 5¾

6. £251. 7s. 10½d. × 208. 7. £95. 12s. 2¾d. × 579.
 8. £12,306. 12s. 6d. × 93. 9. £15,599. 17s. 5d. × 83.
 10. £5625. 13s. 5d. ÷ 38. 11. £25,165. 0s. 0d. ÷ 271.
 12. £15,642. 15s. 11d. ÷ 2908. 13. £30,000 ÷ 7691.
 14. Bring £17. 11s. 7d. to half-pence.
 15. Bring 29,876 pence to £ s. d.

EXERCISE 2 (c).

1. What is the average of £2564. 10s. 9d., £15,463. 18s. 6d., and £15,493. 16s. 3d.?
 2. Find the cost of 135 trucks of coal, each containing 12 tons at £1. 15s. 6d. a ton.
 3. A man's monthly salary is £35. 17s. 6d., and he saves on an average 2 shillings a day. What is his average daily expenditure in a leap year to the nearest penny?

4. The schools of a certain district consist of 121 departments, with an average of 7 classes of 40 scholars each. It 3*s.* 6*d.* per head is allowed per annum for books and apparatus, £5. 5*s.* per department for school libraries and £55 per class for furniture, what is the total cost of these items in the first year?

5. By how much, to the nearest shilling, does $£56,152 \div 147$ exceed $£58,349 \div 189$?

6. Three brothers own a number of houses. *A* owns 5 houses worth £575 each, *B* 4 houses worth £469 each and *C* 8 houses worth £738 each. They agree to sell the houses and divide the proceeds equally. If the houses all sell at these reserve prices, what will each receive?

7. An employer pays each week 351 men and 105 boys. If each man receives £4. 10*s.* 6*d.* and the total cheque for the week's salary bill amounts to £1695. 18*s.* 0*d.*, what does each boy receive, assuming they are all paid equally?

8. How many times is the result of dividing £157. 17*s.* 10*d.* by 43 to the nearest penny contained in £7256. 14*s.* 3*d.*, and how much is left undivided?

REVISION OF WEIGHTS AND MEASURES

14. The "column" methods used for money sums can also be utilised for weights and measures.

Ex. 1. 2 ton 15 cwt. 3 qr. 2 lb. \times 287.

T.	H.	Q.	P.
2	15	3	2
<hr/>			
			287
800	5	1	14
<hr/>			
226	220	20	574
574	2870	861	
<hr/>			
800	1435	881	
<hr/>			
4525			

800 ton 5 cwt. 1 qr. 14 lb.

Ex. 2. 3 ml. 5 fur. 3 ch. 5 yd. 2 ft. \div 86.

M.	F.	C.	Y.	Fr.
		3	9	0
86)3	5	3	5	2
	24	290	770	3
	<hr/>		775	5
	29	293	775	
		258	774	
		<hr/>		1
		35		

3 ch. 9 yd. $0\frac{5}{86}$ ft.

Ex. 3. Bring 15 gall. 3 qt. $1\frac{1}{2}$ pt. to half-pints.

gall.	qt.	pt.	h.-pts.
15	3	1	1
	60	126	254
	<hr/>		255
	63	127	255 half-pints.

Ex. 4. 53 gall. 3 qt. 1 pt. \div 2 qt. $1\frac{1}{2}$ pt.

212	430
<hr/>	
215	431
<hr/>	
862	half-pints.

2 qt. $1\frac{1}{2}$ pt. = 11 half-pints.

$862 \div 11 = 78$ times and 4 half-pints, or 2 pints undivided.

Learn:

1 cubic foot of water weighs 1000 oz. or $62\frac{1}{2}$ lb.

1 gallon of water weighs 10 lb.

AVERAGES

15. The *average* of a series of numbers or quantities is easy to find. It is simply the result of dividing the sum of the terms by the number of terms.

The position is slightly complicated if there are several sets of each number or quantity; but this difficulty is reduced if it is realised that these numbers or quantities might have been written out at length:

e.g. If 3 men receive 2s. and 4 receive 2s. 6d., the series is
2s.; 2s.; 2s.; 2s. 6d.; 2s. 6d.; 2s. 6d.; 2s. 6d.

The average is therefore $\frac{2 + 2 + 2 + 2\frac{1}{2} + 2\frac{1}{2} + 2\frac{1}{2} + 2\frac{1}{2}}{7}$ shillings.

But this is the same as $\frac{3 \times 2 + 4 \times 2\frac{1}{2}}{7}$.

This principle is frequently used:

Ex. 1. A train travels for 3 hours at 20 miles an hour, 4 hours at 25 miles an hour and 2 hours at 10 miles an hour. What is the average rate during the whole time?

In 3 hrs.	60 miles
4 hrs.	100 „
2 hrs.	20 „

∴ In a total of 9 hours the train travels 180 miles.

The average rate is 20 miles an hour.

Ex. 2. 5 pupils score full marks, 100, in an examination paper, one scores 75, two score 36 and one fails to obtain any marks. What is the average for the whole?

5 obtain 100 each.	Total	500
1	75	75
2	36	72
1	0	0

∴ 9 pupils score 647.

Average is $71\frac{2}{9}$ per candidate.

Ex. 3. I buy 5 articles costing 2s. 9d. each, 8 costing 5s. 2d. each, and 4 costing 5s. 0d. each. Another person buys the same number of articles and pays the same total bill, but all the articles were of the same value. What was that value?

$$5 \text{ at } 2\text{s. } 9\text{d.} = 13\text{s. } 9\text{d.}$$

$$8 \text{ at } 5\text{s. } 2\text{d.} = £2. \text{ } 1\text{s. } 4\text{d.}$$

$$4 \text{ at } 5\text{s. } 0\text{d.} = £1. \text{ } 0\text{s. } 0\text{d.}$$

$$\therefore 17 \text{ cost } £3. \text{ } 15\text{s. } 1\text{d.}$$

$$\text{Average} = 4\text{s. } 5\text{d.}$$

EXERCISE 3 (a). MENTAL.

1. Give the number of half-pints in $5\frac{1}{2}$ gall.
2. Bring 257 pints to gallons and pints.
3. How many gallons are there in 35 bushels?
4. 1 lb. 15 oz. \times 16.
5. Bring $\frac{3}{8}$ mile to yards.
6. How many lb. are there in a quarter of a ton?
7. What is the weight of 25 gallons of a liquid twice as heavy as water?
8. What is the capacity of 75 lb. of water?
9. Find the weight of $6\frac{1}{2}$ cub. ft. of water in ounces.
10. What is the volume of 10 oz. of water in cub. in., if 1 cub. ft. = 1728 cub. in.?
11. How many chains are there in half a mile?
12. How many days are there in the last three months of the year?
13. Express $3\frac{1}{4}$ inches \times 36 in yards.
14. Change 88 yards a minute to miles per hour.
15. Reduce 512 drams to lb.
16. Bring $1\frac{1}{4}$ cwt. to lb.
17. How many inches are there in $1\frac{1}{3}$ yards?
18. How many days are there altogether in the four successive Februaries, 1920, 1921, 1922, 1923?
19. Bring $2\frac{1}{4}$ ton to cwt.
20. How many yards are there in $2\frac{1}{2}$ ch.?

EXERCISE 3 (b).

Arrange in columns and add:

1. 3 ton 15 cwt. 73 lb.; 4 ton 13 cwt. 19 lb.; 15 ton 2 cwt. 59 lb.; 3 ton 17 lb.
2. 155 ml. 3 fur. 8 ch.; 5 fur. 6 ch.; 73 ml. 4 ch.; 210 ml. 5 fur.
3. 8 gall. 2 qt. 1 pt.; 1 gall. 1 pt.; 5 gall. 3 qt.; 2 gall. 1 pt.
4. 25 cwt. 2 qr. 7 lb.; 15 cwt. 15 lb.; 1 qr. 9 lb.; 25 cwt. 17 lb.

Arrange in columns and find the difference between:

5. 15 ton and 10 ton 3 cwt. 2 qr.
6. 139 ton and 127 ton 17 cwt. 5 st.
7. 1 ml. and 3 fur. 3 ch. 3 yd.
8. 2 fur. 105 yd. and 1 fur. 219 yd.
9. 3 gall. 1 pt. and 4 gall. 1 qt.
10. 5 bushels 2 qt. and 1 bushel 1 gall.

Multiply:

- | | |
|--|-------------------|
| 11. 3 ton 4 cwt. 1 qr. \times 56. | 12. \times 63. |
| 13. 3 yd. 2 ft. 11 in. \times 72. | 14. \times 103. |
| 15. 2 qt. 1 pt. \times 240 (to gall.). | 16. \times 217. |
| 17. 1 acre 275 sq. yd. \times 35. | 18. \times 55. |

Divide:

- | | |
|--|-------------|
| 19. 4 ton 13 cwt. 2 lb. by 81. | 20. By 56. |
| 21. 42 ml. 1 fur. 3 ch. by 64. | 22. By 162. |
| 23. 1 acre 1569 sq. yd. 4 sq. ft. by 19. | 24. By 159. |

Change:

25. 3 ton 4 cwt. 2 lb. to lbs.
26. 1 cwt. 1 qr. 17 lb. to ounces.
27. 15 gall. 3 qt. 1 pt. to half-pints.
28. 2 ml. 3 fur. to yds.
29. 5 wk. 2 dy. 15 hr. to hrs.
30. 5 ac. 2719 sq. yd. 3 sq. ft. to sq. ft.
31. 42895 lb. to tons and lbs.
32. 17965 feet upwards to miles, yards, feet.

EXERCISE 3 (c).

1. How many times can 3 yd. 2 ft. 1 in. be cut from a length of wire a quarter of a mile long?
2. How many miles are travelled in 5 hr. 20 min. at the rate of $18\frac{3}{4}$ ml. an hour?
3. Find in the shortest way the total weight of 224 sacks of cement, each weighing 2 cwt. 3 qr. 21 lb.
4. A man takes 110 strides in walking 100 yards. He walks along the sides of a rectangular field, taking 176 strides for each of the long sides and 121 strides for each of the short ones. Find the dimensions of the sides.
5. Express $16\frac{1}{2}$ gall. as litres, being given that 100 litres = 176 pints.
6. The average weight of 10 packages is 10 lb. 2 oz. Six packages are added, and the average weight is now 20 lb. Find the average weight of the six added packages.
7. A rectangular field is surrounded by a fence 456 yards long, and one of the sides measures 108 yards. Find the length of the adjacent side.
8. The number of customers served each hour between 9 a.m. and 4 p.m. in a certain restaurant were: 9-10, 18; 10-11, 10; 11-12, 20; 12-1, 60; 1-2, 55; 2-3, 20; 3-4, 13. Find the average number served per hour.
9. In an office certain clerks receive £5 per week, four times as many receive £4. 10s. per week, and ten times as many receive £2. 10s. per week. What is the average weekly wage per man?
10. A man cycled 50 miles one day, 27 the next, 35 the 3rd, 48 the 4th, and 52 the 5th. How many miles did he travel on the sixth day if his average for the 6 days was 46 miles?

DECIMALS

ADDITION AND SUBTRACTION. THE METRIC SYSTEM.

16. Place Values.

Consider the number 111. The value of each digit is ten times that of the one which follows, and one-tenth of the one which precedes it.

We can therefore continue such a series as follows:

$$111 \frac{1}{10} \frac{1}{100} \frac{1}{1000} \frac{1}{10000} \text{ etc.,}$$

but such an arrangement would be too cumbersome, and hence we continue the digits as far as the unit figure but place a dot, known as the *decimal point*, after the last unit figure and before the first figure with a fractional value, thus:

$$111.1111 \text{ etc.}$$

Each figure in such a quantity has therefore a place value; e.g. in the quantity 25.379,

The figure 2 signifies 20, or 2 tens,

$$5 \qquad 5 \text{ units,}$$

$$3 \qquad \frac{3}{10},$$

$$7 \qquad \frac{7}{100},$$

$$9 \qquad \frac{9}{1000}.$$

It is clear, too, that a decimal fraction such as .37 can be brought to an equivalent vulgar fraction with a *power* of ten for the denominator,

$$.37 = \frac{37}{100}.$$

The decimal system is largely used in scientific calculations, and it forms the basis of the systems of weights and measures used in most countries except our own.

17. Metric System.

The *Metric System* of weights and measures and of money is a decimal system, each place value, from 10,000 times the unit to the thousandth part of it, having a definite name, though some of these names are rarely used.

The multiples of the units are indicated by the following prefixes:

Deca-	to indicate 10 times,
Hecto-	100 times,
Kilo-	1000 times,
Myria-	10,000 times.

In each of these a *capital* letter is generally employed.

The subdivisions of the unit have the following prefixes:

deci-	to indicate $\frac{1}{10}$,
centi-	$\frac{1}{100}$,
milli-	$\frac{1}{1000}$.

In each of these a *small* letter is generally employed.

Example. Table of Length.

Myriametre, Kilometre, Hectometre, Decametre, metre, decimetre, centimetre, millimetre.

Hence 54356·297 metres is composed of:

5	Myriametres,
4	Kilometres,
3	Hectometres,
5	Decametres,
6	metres,
2	decimetres,
9	centimetres,
7	millimetres.

Similarly 4 Km. 3 m. 7 dm. 8 mm.

= 4003·708 metres

= 4·003708 Kilometres

= 400370·8 centimetres, etc.

Note.

Kilometre is written Km.; decimetre dm., etc.

The Metric System is taught in British Schools because:

1. It is the system generally employed in scientific calculations.

2. It is useful to understand the system used in other countries.
3. It may eventually be introduced commercially in England.

Learn.

Length. Unit 1 *metre*. 1 metre = 39·3708 inches, approximately; or 1 yard 1 foot.

Capacity. Unit 1 *litre*. 1 litre = $1\frac{3}{4}$ pints, approximately.

Weight. Unit 1 *gram*. 5 Kilograms = 11 lb., approximately.

Ex. 1. Express in metres the sum of 5 Km. 8 Dm. 4 m. 3 dm. 5 cm.; 4 Km. 3 cm.; 2 Hm. 9 m.; 2 Dm. 75 mm.

Km.	Hm.	Dm.	m.	dm.	cm.	mm.
5		8	4	3	5	
4					3	
	2		9			
		2			7	5
9	3	1	3	4	5	5

9313·455 metres. *Ans.*

Ex. 2. Bring 1 Kg. 3 g. 4 cg. to mg.

Kg.	Hg.	Dg.	g.	dg.	cg.	mg.
1			3		4	

1003040 mg. *Ans.*

Ex. 3. Add together 5·708, 25·1906, 3001·48, ·379.

5·708
25·1906
3001·48
·379

3032·7576 *Ans.*

Thus, for the addition of decimals no new rule has to be learnt, since each figure has its place value and all figures of the same place value are put in the same column; similarly with subtraction.

Ex. 4. Take ·3019 from 25·1002.

25·1002
·3019
24·7983 *Ans.*

Note.

It is important that the figures in the above examples shall be placed in columns according to their place values.

Ex. 5. Express 3032·7576, 24·7983, and 3·2817 to the nearest unit, tenth, hundredth, thousandth.

	3032·7576	24·7983	3·2817
Nearest unit	3033	25	3
Nearest tenth	3032·8	24·8	3·3
Nearest hundredth	3032·76	24·80	3·28
Nearest thousandth	3032·758	24·798	3·282

That is to say, if the figure following the last to be used is 5 or greater than 5, we add 1; if it is less than 5, we ignore it.

EXERCISE 4 (a). MENTAL.

1. Give as a fraction the place value of the figure 7 in 10·27.
2. Give also the place value of the 1.
3. Express as a fraction ·13.
4. Find the difference of the place values of the two 5's in ·55.
5. $3·56 + 1·08 + ·76 + ·5$.
6. $1·28 + 3·5 + ·075 + ·25$.
7. $·128 + ·376 + ·015 + ·0098$.
8. $564·15 + 378·02 + 2916·125$.
9. $5·6 - 3·8$.
10. $2·07 - 1·09$.
11. $11·056 - 10·969$.
12. Bring 1 m. 3 cm. to cm.
13. Bring 1 Kg. 5 g. to g.
14. How many metres are there in 35,000 mm.?
15. How many Kilograms are there in 12,000 grams?
16. How many inches are equivalent to a Kilometre?
17. Express 8 litres approximately in pints.
18. How many lbs. are roughly equal to 15 Kilograms?
19. Find the average of 1·25, 2·75 and 2·0.
20. Express 25·0752 to the nearest unit, tenth, hundredth and thousandth.

EXERCISE 4 (b).

Arrange in vertical columns and add :

1. 985·24, 11·4, 7160, 231·6, 32, 99·434.
2. 32·768, 8·822, 10·05, 81·674, 32·67, 434·16, 318·58, 4, 503·9, 65.
3. 207·47, 2·9, 392·8, 54, 94·89, 21·657, 7·711, 8·94, 970, 21·56.
4. 537·1086, 29·293, 8·0807, ·952, ·86, 1·342, 5·0076.

Add horizontally :

5. $5·671 + ·087 + 6·912 + ·08 + 1·59 + 6·005$.
6. $15·987 + 16·52 + ·008 + ·08 + 1·72$.
7. $271·52 + 30·108 + 46·9 + 512·7391$.

Subtract the smaller from the larger in the following:

8. 25·1286, 17·925.
9. ·510, 1·4876.
10. 293·05, 285·176.
11. ·008765, ·006198.

What must be added to each of the following so that the total will be 1000 in each case?

12. 52·96, 1·95, 482·07, 251·5.
13. 169·05, 72·525, 108·63, ·57.

14. Add together 35·64 metres, 375·9 cm. and 1569 mm. and express the answer in metres.

15. By how many milligrams does 5·0087 Kilograms exceed 4 Kilograms 3 grams 5 centigrams?

16. Add vertically and horizontally:

$$\begin{array}{r}
 5·625 + 29·16 + 105·018 + 3·1098 = \\
 17·108 + 419·0087 + 9·209 + 23·987 = \\
 207·98 + 64·506 + 361·137 + 9·1076 = \\
 ·1596 + 8·87 + 408·104 + ·0065 = \\
 ·0087 + ·1903 + 95·65 + 56·009 = \\
 \hline
 = \quad + \quad + \quad + \quad =
 \end{array}$$

FACTORS

INCLUDING H. C. F., L. C. M., SQUARE AND CUBE ROOTS BY FACTORS.

18. The numbers 1, 3, 5, 7, 11, 13, 17 are amongst those that cannot be divided exactly by any number except themselves and 1. Such numbers are called *Prime Numbers*.

All others are divisible by at least one other number; e.g. 18 is divisible by 2, 3, 6 and 9; 20 is divisible by 2, 4, 5, 10; and so on. All these divisors are said to be *Factors* or *Measures* of the given numbers. Factors which are also Prime Numbers are called *Prime Factors*.

A number which contains another number is said to be a *Multiple* of it.

Ex. 1. Find the Prime Factors of 336.

(a) *Method 1.*

$$\begin{array}{r|l} 8 & 336 \\ 2 & 42 \\ 3 & 21 \\ & 7 \end{array}$$

This consists in dividing by 2 as often as possible, then by 3, and if possible 5, 7 etc., in order. Dividing by 8 is equivalent to dividing by 2 three times.

The Prime Factors of 336 are therefore **2.2.2.2.3.7** or **$2^4.3.7$** .

(b) *Method 2.*

$$336 = 8.42 = 8.2.21 = 8.2.3.7 = \mathbf{2^4.3.7}.$$

Ex. 2. Find the largest factor common to both 126 and 168.

$$126 = 2.63 = 2.9.7 = 2.3^2.7,$$

$$168 = 8.21 = 8.3.7 = 2^3.3.7.$$

The common Prime Factors are **2.3.7**.

\therefore The largest common factor is 42.

This result is known as the *Highest Common Factor* or H.C.F. of the given numbers. It is also known as the *Greatest Common Measure* or G.C.M.

Ex. 3. What is the smallest number which contains both 126 and 168?

$$126 = 2 \cdot 3^2 \cdot 7,$$

$$168 = 2^3 \cdot 3 \cdot 7.$$

We must include the highest power of each factor used; thus $2 \cdot 3 \cdot 7$ contains only one of the three factors 2 in 168, and only one of the two factors 3 in 126.

\therefore The smallest such number is $2^3 \cdot 3^2 \cdot 7$ or 504.

This result is known as the *Least Common Multiple* or L.C.M. of the given numbers.

Ex. 4. What is the greatest quantity that can be measured an exact number of times from 2 tons 15 cwt. and 1 ton 10 cwt.?

This is clearly the *Greatest Common Measure*.

$$2 \text{ tons } 15 \text{ cwt.} = 55 \text{ cwt.} = 5 \cdot 11,$$

$$1 \text{ ton } 10 \text{ cwt.} = 30 \text{ cwt.} = 2 \cdot 3 \cdot 5,$$

$$\text{G.C.M.} = 5 \text{ cwt.}$$

19. Occasionally the numbers of which the H.C.F. or the L.C.M. is required are too cumbersome for the use of the above methods, e.g. 17009, 8621. The following is the method used in such cases

1)8621	17009(1
8388	8621
<u>233</u>	<u>8388</u> (16
	699
	<u>1398</u>
	<u>1398</u>

The above is a process of dividing backwards and forwards, using the remainder in one column as the divisor into the other; e.g. 8621 goes once into 17009 and leaves a remainder 8388. This goes once into 8621 and leaves 233.

This number, 233, becomes the *last divisor*, for it divides exactly 16 times into 8388. This last divisor is the H.C.F.

By division we can find the other factors of the numbers:

$$8621 = 233 \times 37,$$

$$17009 = 233 \times 73,$$

$$\therefore \text{L.C.M.} = 233 \times 37 \times 73.$$

Notice that

$$8621 \times 17009 = (233 \times 37 \times 73) \times 233,$$

i.e. *The product of the two numbers is equal to the product of H.C.F. and L.C.M.*

Ex. 5. Find the Square Root of 1764 by the method of Prime Factors. **Note.** *The square root of a number is a quantity which, when multiplied by itself, gives the number.*

$$1764 = 4 \cdot 441 = 4 \cdot 9 \cdot 49 = 2^2 \cdot 3^2 \cdot 7^2,$$

$$\therefore \text{Sq. Rt.} = 2 \cdot 3 \cdot 7 = 42.$$

This result may be written $\sqrt{1764} = 42$.

Ex. 6. Find the Cube Root of 74088.

Note.

3 is called the cube root of 27 because $3 \times 3 \times 3 = 27$,

5 is called the cube root of 125 because $5 \times 5 \times 5 = 125$.

These results are often written as follows:

$$\sqrt[3]{27} = 3,$$

$$\sqrt[3]{125} = 5.$$

$$74088 = 8 \cdot 9261 = 8 \cdot 9 \cdot 1029 = 8 \cdot 9 \cdot 3 \cdot 343$$

$$= 8 \cdot 9 \cdot 3 \cdot 7 \cdot 49 = 2^3 \cdot 3^3 \cdot 7^3.$$

$$\therefore \text{Cube Rt.} = 2 \cdot 3 \cdot 7 = 42.$$

EXERCISE 5 (a). MENTAL.

What are the Prime Factors of:

1. 18, 35, 42, 70, 48?
2. 20, 50, 100, 200, 500?
3. 15, 25, 75, 125, 375?

Find the H.C.F. of:

- | | |
|-----------------|----------------|
| 4. 56 and 84. | 5. 27 and 72. |
| 6. 105 and 140. | 7. 120 and 75. |

Find the L.C.M. of:

- | | |
|---------------------|-----------------|
| 8. 2, 3, 4, 5, 6. | 9. 4, 6, 8, 12. |
| 10. 15, 20, 30, 60. | 11. 17, 34, 51. |

What are the Square Roots of:

12. 144, 81, 256, 100?

13. 900, 729, 529, 576?

14. Find the value of $2^2 \cdot 3^2$.

15. What is the largest quantity contained exactly in both 1 lb. 4 oz. and 1 lb. 14 oz.?

16. Find the smallest sum of money that can be paid exactly in half-crowns, florins, and five-shilling pieces.

17. Three bells start tolling together, and continue to toll at intervals of 10, 12 and 15 seconds. After what time will they all be tolling together again?

18. How many numbers between 1 and 30 are exactly divisible by 9?

EXERCISE 5 (b).

Find in order the Prime Factors of:

1. 245. 2. 294. 3. 540. 4. 480. 5. 1728. 6. 1225.

Calculate the H.C.F. and L.C.M. of the following, giving answers as the products of factors, and the H.C.F. also as a single number

7. 168, 192, 216.

8. 378, 462, 504.

9. 525, 675, 750.

10. 144, 216, 360.

Find by continued division the H.C.F. of:

11. 4473 and 4189.

12. 2793 and 3325.

13. 9537 and 10,659.

14. 4671 and 6055.

Find H.C.F. and L.C.M., expressed in factors, of:

15. $3^2 \cdot 5^2 \cdot 7$ and $3 \cdot 5^2 \cdot 7^2$.

16. $2 \cdot 3^2 \cdot 5^3$ and $2^2 \cdot 3 \cdot 5^2 \cdot 11$.

17. $2^4 \cdot 11 \cdot 13$ and $2^3 \cdot 11^2 \cdot 13$.

18. $5^3 \cdot 11 \cdot 17$ and $2 \cdot 5^2 \cdot 11^2$.

EXERCISE 5 (c).

1. What is the greatest sum of money contained exactly in both 6s. 8d. and 10s.?

2. The product of the four numbers 52, 51, 50 and 49 is divided by the product of 2, 3, 5 and 7. What is the quotient?

3. Find the least number which contains exactly 36, 51, 102 and 153.

4. Three bells toll at intervals of 12, 18 and 24 seconds. If they start tolling together, how long will it be before they are together again?

5. Find the least weight which can be divided into exactly equal parts of either 8 lb., or 12 lb. 4 oz.

6. Two persons walk so that their paces are of 30 and 32 inches respectively. If they start in step with the left foot, on how many other occasions will their left feet touch the ground at the same moment in a walk of 240 yards?

7. What is the length of the side of the greatest cube that can be cut a number of times from a piece of timber 41 ft. 8 in. long, and 30 in. by 25 in. in cross section, if there is assumed to be no waste?

SECTIONAL REVISION A

EXERCISE 6 (a). MENTAL.

1. $5684 + 29 + 1076 + 829$. 2. $5000 - 1876$.
3. £1. 15s. $7\frac{1}{2}d.$ + £25. 16s. $3\frac{1}{4}d.$ + £5. 13s. $9\frac{1}{2}d.$
4. £100 - (£25. 13s. $6d.$ + £41. 15s. $6d.$ + £10. 2s.).
5. $57,825 \div 9$. 6. 3 lb. 4 oz. 4 dr. $\times 8$.

Find the cost of:

7. 5 dozen articles at $4\frac{1}{2}d.$ each.
8. 2 lb. 7 oz. at 1s. $4d.$ per lb.
9. 250 articles at 15s. per hundred.
10. 7 score articles at 1s. $6d.$ each.
11. Find the Prime Factors of 208.
12. What quantity is contained exactly in both 3s. $6d.$ and 2s. $4d.$?
13. Add together 1.125 and 2.875.
14. Find the difference between .087 and unity.
15. What is the tenth part of £17. 3s. $9d.$?
16. 3 m. 2 cm. + 1 m. 5 dm. + 4 m. 2 dm. 3 cm.
17. How many articles at 7s. $6d.$ each can be obtained for £7. 10s., and how many for £37. 10s.?
18. Find the total cost of 3 first-class and 4 third-class tickets for 20 miles, if the former cost 2d. a mile and the latter $1\frac{1}{2}d.$ a mile.
19. What is the cost of 241 articles at 1s. $9d.$ each?
20. Find the value of 2560 half-crowns.

EXERCISE 6 (b).

1. 4876×328 . 2. $180,763 \div 1598$.
3. Bring 356 tons 13 cwt. 12 lb. to lbs.
4. Find the cost of 765 articles at £5. 17s. $5\frac{1}{2}d.$ each.
5. How many times can I take 5 lb. 13 oz. from 56 cwt.?
6. Bring 5 m. 3 cm. to mm., and from the result take 4864 mm.
7. Find all the Prime Factors of 9240.

8. How many times is $9\frac{1}{2}d.$ contained in £20. 5s. 4d.?
9. $(175 \times 25) + (175 \times 136).$
10. Enter and total the Balance Column:

| Day | Payments | Receipts | Balance |
|-----------|------------------------|------------------------|---------|
| | £ s. d. | £ s. d. | £ s. d. |
| Monday | 36 17 10 $\frac{1}{2}$ | 43 19 6 | |
| Tuesday | 96 3 7 | 117 7 6 | |
| Wednesday | 48 16 3 $\frac{3}{4}$ | 59 19 10 $\frac{1}{2}$ | |
| Thursday | 19 6 8 | 35 16 8 | |
| Friday | 55 17 11 $\frac{3}{4}$ | 59 3 7 $\frac{1}{2}$ | |
| Saturday | 108 15 4 $\frac{1}{4}$ | 120 13 7 $\frac{3}{4}$ | |
| | | | |

EXERCISE 6 (c).

1. What is the average of all numbers from 8 to 29?
2. How many pairs of gloves can I get for £22 at the rate of 2s. 9d. per pair?
3. How much shall I save during March, April and May at 1 $\frac{1}{2}d.$ per day?
4. Make out a bill for the following:
 - 13 $\frac{1}{4}$ qr. of Oats at 28s. per qr.
 - 116 tons of Hay at £4. 17s. 6d. per ton.
 - 19 $\frac{1}{4}$ cwt. of Barley at 12s. 6d. per cwt.
 - 18 $\frac{1}{2}$ qr. of Wheat at £2. 1s. 6d. per qr.
5. Soap costs £1. 16s. 0d. per cwt. A firm bought 1 ton 4 cwt., and by an error was charged for 14 cwt. By how much was the account wrong?
6. Find the cost of 217,520 lb. of tea, sold at an average price of 1s. 5 $\frac{1}{4}d.$ per lb.
7. A provision dealer buys a side of bacon weighing 72 lb. for 66s. Allowing 8 lb. for waste, at what price per lb. must he sell the remainder so that he may make a gross profit of approximately £1. 5s.?

8. A man pays £31. 3s. 4d. for rates on his house, the rates being 11s. 4d. in the £. What is the rateable value of the house?

9. A motor car ran the following number of miles:

| | |
|----------------|----------------|
| July 670 miles | Oct. 838 miles |
| Aug. 754 „ | Nov. 524 „ |
| Sept. 920 „ | Dec. 326 „ |

(a) What was the average mileage per month?

(b) Assuming that the car ran 40 miles per gallon of petrol, find the number of gallons used during September in excess of the average quantity per month.

10. In a certain borough, the cost of Education is £185,315, and this is met by a rate of 1s. 7½d. in the £. Find the rateable value of the borough.

EXERCISE 7 (a). MENTAL.

1. Add

9,385
7,943
85,869
78,594
253,678
12,819

2. From £ s. d.
59,713 16 7½
Take 29,958 19 9¼

3. From ml. fur. yd.
9 3 150
Take 3 7 200

4. 257,135 - 97,219.

5. £5. 15s. 6¾d. × 9.

6. £1. 3s. 4½d. + £23. 12s. 5¼d. + £156. 18s. 3¾d.

7. How many boys can receive 6½d. out of 13s.?

8. Express in words the number 290,005.

9. What is the actual value of the figure 7 in the number 107,654?

10. Find the wages for 44 hours at 1s. 9d. per hour.

11. What is the cost of 5 score articles at 3s. 6d. each?

12. 537 × 25.

13. 1½ yards at 4s. per yard.

14. Find the cost of 3 tons 15 cwt. of coal at 28s. per ton.

15. 1.305 + 2.87 + 1.306 + .005.

16. 1.005 - .8762.

17. Bring 1 m. 3 dm. 5 cm. to cm.

18. Find the L.C.M. of 4, 6, 8, 10, 12.

19. If I save 5s. every day in a year that is not a leap year, what are the total savings for the year?

20. What are the total wages of 3 men and 4 boys for 4 weeks if each man receives £3 a week and each boy 10s. 6d.?

EXERCISE 7 (b).

1. £561. 15s. 9d. \div 280. 2. 1 ton 3 cwt. 17 lb. \times 75.

3. Bring 59,653 ft. to ml. fur. ch. yd. ft.

4. Divide $3\frac{1}{2}$ million by five thousand and forty-three to the nearest unit.

5. Find the quotient when 5 tons 13 cwt. is divided by 2 cwt. 2 qr.

6. What is the cost of 5659 Kilometres at £1. 17s. 6d. a Kilometre?

7. Divide the L.C.M. of 54, 72, 108 by the G.C.M.

8. Find the Prime Factors of 105 and 385, and hence find their G.C.M. and L.C.M.

9. Find a short method for working $(882 \times 87) \div (87 \times 84)$.

10. Add both vertically and horizontally and enter the grand total:

| | | | | |
|--------|--------|---------|---------|--|
| 86 | 960 | 56,483 | 5,862 | |
| 719 | 7,158 | 298,758 | 89 | |
| 5,834 | 3,265 | 6,942 | 153,768 | |
| 7,192 | 48 | 318,939 | 39,404 | |
| 35 | 97,193 | 574,514 | 1,695 | |
| 28,974 | 58,718 | 7,180 | 45,769 | |
| | | | | |

EXERCISE 7 (c).

1. How much shall I save in a leap year and the following year at $1\frac{3}{4}$ d. a day?

2. How many times is 9 millimetres contained in 2.5 decimetres? Give the answer to the nearest whole number.

3. If one person can live on 7s. 4d. a day, what will it cost to keep 55 persons for a week?

4. Find all the numbers less than 7500 and greater than 7000 which are perfect squares, if $7056 = 84^2$.

5. In the Argentine, 22,857 acres of land were sold for £146,415. 8s. 4d. Find, to the nearest shilling, the average price per acre.

6. What is the cost of 18,500 cubic feet of gas at 4s. 1d. per 1000 cubic feet?

7. The answer to the question, "Divide 961132105 by 17" is given as $56537182\frac{1}{17}$. Find the missing numerator of the fraction.

8. A joiner pays 1s. 3d. a lb. for nails, each lb. containing 270 nails. He is nailing floor boards, and uses 3 nails every 18 inches. He uses 6000 feet of floor boards. How much will the nails cost him?

9. A rubber company produces rubber at an average cost of $7\frac{1}{2}$ d. per lb. In a year it produced 100,800 lb. of rubber, 59,200 lb. of which were sold at 1s. $10\frac{1}{2}$ d. per lb., and the rest at 2s. $1\frac{1}{2}$ d. per lb. Find the year's profit.

10. When coal is 48s. per ton, the cost of a fire, burning during the 26 weeks of winter for 15 hours a day, comes to £6. Find the number of lbs. of coal burned per hour, to the nearest lb.

EXERCISE 8 (a). MENTAL.

1. Add

| £ | s. | d. |
|---------|----|-----------------|
| 15,729 | 18 | $7\frac{1}{4}$ |
| 9,256 | 12 | $4\frac{1}{2}$ |
| 75,872 | 16 | $9\frac{3}{4}$ |
| 956 | 9 | 8 |
| 372,645 | 19 | $7\frac{1}{2}$ |
| 9,528 | 14 | $11\frac{1}{2}$ |

2. From 305,062

Take 198,658

tons cwt. lb.

3. From 35 8 64

Take 17 15 96

4. $18,642 + 987 + 6034 + 8726 + 9$.

5. $75,286 - 29,798$.

6. $398,765 \div 6$.

7. Into how many packages weighing 1 lb. 4 oz. can 20 lb. be divided?

8. Write in figures the number eight hundred and eight thousand and ten.

9. How many times is the quantity 18 inches divisible into 3 yards?

10. Find the cost of 3 dozen articles at $5\frac{1}{4}d.$ each.

11. A chair costing £2 is sold for fifty-two shillings. What is the gain?

12. What is the cost of $3\frac{1}{2}$ yards at 18s. 4d. a foot?

13. $9125 \div 25$.

14. 768×99 .

15. $\cdot 0065 + \cdot 0763 + \cdot 0008 + \cdot 0595$.

16. Find the cost of 20 dozen articles at $1\frac{1}{2}d.$ each.

17. Take 256 cm. from 4 m. 7 cm., and give the answer in centimetres.

18. What is the greatest common measure of 5s. and 3s. 4d.?

19. Find the cost of 42 books at half a guinea each.

20. Express a quarter of a million in figures.

EXERCISE 8 (b).

1. $1,296,543 \div 89,564$ (to nearest unit).

2. £37. 15s. $7\frac{1}{2}d.$ $\times 495$.

3. Bring 565 tons 73 lb. to lbs.

4. 5 yd. 2 ft. 9 in. $\times 72$.

5. How many times is 3s. $4\frac{1}{2}d.$ contained in £5. 17s. 6d., and what quantity remains undivided?

6. Add together 3 Kg. 4 g. 3 cg.; 2 Kg. 23 cg.; 5 Kg. 156 mg.; and give the answer in grammes.

7. What is the L.C.M. of 24, 36, 42, 56?

8. Work in the shortest way you can 897×999 .

9. Simplify $(29)^3 - 5 \times (39)^2$.

10. Enter cross totals and grand total:

| | | | | Totals |
|-------------|--------|--------|--------|--------|
| 43,789 | 69,543 | 28,974 | 42,689 | |
| 3,456 | 789 | 7,986 | 97 | |
| 70 | 16,587 | 35 | 7,964 | |
| 9 545 | 7,649 | 9,852 | 938 | |
| Grand Total | | | | |

EXERCISE 8 (c).

1. If 20 tons 10 cwt. of coal, costing 42s. per ton, is sold at 2s. 6d. per cwt., what is the total gain or loss?

2. A train leaves Bristol for London at 9.56 a.m., and after stopping 10 min. at each of three stations arrives at London at 12.24 p.m. If the distance is 118 miles, what is the average rate in miles per hour?

3. What is the total length to the nearest foot of a drain that is made from 635 drain pipes, each 1 foot 1 inch long, and 927 pipes each 1 foot 3 inches long, allowing 1" for overlap in each case?

4. Find the total cost of $4\frac{1}{2}$ yd. of silk at 7s. 11d. per yard; $5\frac{1}{2}$ yd. of calico at 1s. 10½d. per yard; and 6 yd. of trimming at 1s. 11¾d. per yard.

5. A boy starts on January 1st, 1928 to save by putting 2d. every day into a money-box. On what date will he have saved enough to buy a 15s. 6d. War Savings Certificate?

6. In 1911 the number of paupers in England was 833,809 and the amount of Poor Rate levied was £12,062,979. Find, to the nearest shilling, the average amount that each pauper cost the country.

7. In an examination 9 candidates received 97 marks each, 25 received 79 each, 33 received 57 each, and 69 received 40 each. Find the average marks of the whole number examined, to the nearest whole number.

8. A tradesman bought 1000 articles at 1s. 7¼d. each, and 850 at 2s. 9d. each. How much did he pay for them altogether?

9. The average time taken to admit a person to an exhibition through a turnstile is $4\frac{1}{2}$ seconds. How many turnstiles are required to admit 15,000 persons in $\frac{3}{4}$ of an hour?

10. A season ticket for 13 weeks to a certain place is £4. 1s. 6d., but the return fare for the journey is 5s. 4½d. How much will a person save in this period by taking a season ticket if he has to travel to and from the place twice a week?

EXERCISE 9 (a). MENTAL.

| | yd. | ft. | in. | | £ | s. | d. |
|--------|-----|-----|-----|---------|--------|-----|----------|
| 1. Add | 735 | 2 | 11½ | 2. From | 35,896 | 10 | 0 |
| | 39 | 1 | 10 | Take | 2,898 | 17 | 5½ |
| | 57 | 2 | 5¾ | | | | |
| | 168 | 1 | 1½ | 3. | 15,642 | × | 8. |
| | 834 | 0 | 2¼ | 4. | £395. | 6s. | 8d. ÷ 7. |

5. £9. 12s. 7½d. + £57. 16s. 9¾d. + £875. 19s. 6¼d. + £59. 17s.
6. What are the wages for 48 weeks at £1. 2s. 6d. per week?
7. How many 5¾d. tablets of soap can be bought for 5s. 9d.?
8. How is the date MDCCXXXV expressed in ordinary notation?
9. Find the cost of 3 score articles at 1s. 6d. each.
10. What is the fifth part of 2 hours 5 minutes?
11. Find the cost of 575 articles at 2s. per 100.
12. $(56 + 64) \div (61 - 46)$.
13. 340×102 .
14. $2\cdot732 + 4\cdot896 + 4\cdot935 + 8\cdot961 - 3\cdot896 - 5\cdot935$.
15. What is the cost of 8500 envelopes at 12s. 6d. per 1000?
16. Find the H.C.F. of 72 and 90 by inspection.
17. What do I gain by buying 10 dozen articles at 1s. per doz. and selling them at 1½d. each?
18. How many posts 6 feet apart are required to mark the distance of a mile?
19. How many 5s. 6d. railway tickets can be obtained for £5. 10s., and how many for £27. 10s.?
20. What is the cost of 320 hats at 17s. 6d. each?

EXERCISE 9 (b).

1. $14,654 + 109,836 + 59,496 + 87,032 - (156 + 90,024)$.
2. $576,432 \div 3008$.
3. £159. 17s. 4½d. $\times 329$.
4. Change 3 ml. 2 fur. to yards.
5. From the sum of 2·006, 4·498, 2·5, 7·006 take the sum of 3·008 and 9·592.

6. How many times is 5 lb. 4 oz. contained in 2 cwt. 6 lb 2 oz., and how much remains undivided?
7. Find the H.C.F. of 64,530 and 65,008.
8. Work in the shortest way you can £39. 19s. $11\frac{1}{2}d.$ \times 560.
9. Work out $(137)^3$ and give the answer to the nearest thousand.

10. Add

| ml. | yd. | ft. | in. |
|-----|-----|-----|-----|
| 2 | 290 | 2 | 10 |
| 3 | 480 | 1 | 11 |
| 1 | 250 | 0 | 9 |
| 5 | 630 | 2 | 6 |
| 4 | 140 | 2 | 8 |

EXERCISE 9 (c).

1. If a franc is worth $9\frac{1}{2}d.$, how many francs can be obtained for £693. 15s.? Give the result to the nearest whole number.

2. During a journey of 158 miles I travel 25 miles at 30 miles an hour, 50 at 40 miles an hour, and the rest at 60 miles an hour. How long does the journey take?

3. At Bradford 336 lb. of Lincoln hog wool were sold at $10\frac{1}{2}d.$ per lb. and 112 lb. of ewe and wether wool at $9\frac{3}{4}d.$ per lb. Find the average price received for the whole.

4. If 13 men and 25 boys receive in all £20. 6s. a day, and each man receives 2s. more than each boy, how much does each man receive?

5. In 1908 the total value of the exports of the United Kingdom was £377,103,824 and this amounted to about £8. 11s. 0d. per head of the population. Find the population to the nearest thousand.

6. Cheese is sold at £5. 9s. per cwt. If the retail price is one fifth greater than the wholesale price, find, to the nearest penny the retail price of 1 lb.

7. On a 38 days' voyage a liner averaged 305 miles per day. Its average for the first 11 days was 280 miles per day, and for the next 15 days 316 miles per day. What was its average per day for the rest of the time to the nearest mile per day?

8. Find what the customer will pay altogether for the following items, after deducting $6d.$ in each complete £ for cash:

$16\frac{1}{2}$ lb. of currants at $11\frac{1}{2}d.$ per lb.

36 lb. of flour at 3 lb. for $8\frac{1}{2}d.$

$11\frac{3}{4}$ lb. of peel at $1s. 6d.$ per lb.

$2\frac{3}{4}$ lb. of almonds at $2s. 4d.$ per lb.

$2\frac{3}{4}$ lb. of butter at $2s. 5d.$ per lb.

$2\frac{1}{2}$ dozen eggs at $3s. 6d.$ per doz.

6 oz. of ground spice at $3s. 4d.$ per lb.

9. The cost of 6 lb. 8 oz. of bacon was $12s. 2\frac{1}{4}d.$ What was the price per lb.?

10. The first £225 of a man's income was exempt from Income Tax. The remainder of his income was taxed at the rate of $2s. 6d.$ in the £. If he paid £25. 5s. in Income Tax, what was his total income?

VULGAR FRACTIONS

PRELIMINARY PROCESSES. ADDITION. SUBTRACTION.

20. Some Definitions.

A *Fraction* is a part or parts of a whole, e.g. 6 in. = $\frac{1}{2}$ ft., 4 in. = $\frac{1}{3}$ ft., 8 in. = $\frac{2}{3}$ ft. Similarly $\frac{3}{8}$, $\frac{27}{5}$, $\frac{17}{349}$ are fractions. They may be greater or less than unity.

The number above the line is called the *Numerator*, and the one below the line the *Denominator*; e.g. in the fraction $\frac{7}{11}$ the Numerator is 7 and the Denominator 11.

A *Proper Fraction* is one in which the Numerator is *less* than the Denominator, e.g. $\frac{5}{6}$, $\frac{1}{8}$; an *Improper Fraction* is one in which the Numerator is *equal to or greater than* the Denominator, e.g., $\frac{9}{8}$, $\frac{11}{5}$.

A *Mixed Number* consists of a whole number and a fraction, e.g., $5\frac{1}{2}$, $107\frac{3}{4}$.

21. Mixed Numbers and Improper Fractions.

Mixed Numbers can be changed to Improper Fractions.

Consider the mixed number $3\frac{3}{4}$. This consists of 3 units and three quarters. There are 4 quarters in a unit, and hence 12 quarters in 3 units. Altogether there are $12 + 3$ quarters.

$$\therefore 3\frac{3}{4} = \frac{15}{4}.$$

Other Examples:

$$(1) \quad 2\frac{1}{7} = \frac{14 + 1}{7} = \frac{15}{7}.$$

$$(2) \quad 13\frac{7}{8} = \frac{104 + 7}{8} = \frac{111}{8}.$$

22. Improper Fractions can be changed into Whole Numbers or Mixed Numbers.

This is the reverse process to the above.

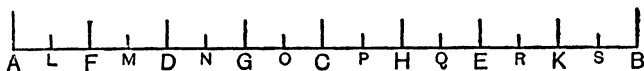
Examples:

$$(1) \quad \frac{217}{11} = 19 \text{ and } 8 \text{ over.}$$

The remainder consists of 8 of the 11 equal parts into which the unit is divided, and therefore = $\frac{8}{11}$.

$$\therefore \frac{217}{11} = 19\frac{8}{11}.$$

$$(2) \quad \frac{435}{9} = 48\frac{3}{9}.$$

23. *Reducing Fractions to Lowest Terms.*

The line AB , which represents a unit of length, is here divided into 16 equal parts. AE includes 12 of these equal parts.

$$\therefore AE = \frac{12}{16} \text{ of } AB,$$

and since AB is our unit, $AE = \frac{12}{16}$.

But AB is also divided into 8 equal parts at F, D, G, C, H, E, K , and AE includes 6 of these equal parts.

$$\therefore AE = \frac{6}{8}.$$

Finally AB is divided into 4 equal parts at D, C, E , and AE includes 3 of these equal parts.

$$\therefore AE = \frac{3}{4}.$$

$$\therefore \frac{12}{16} = \frac{6}{8} = \frac{3}{4}.$$

$\frac{3}{4}$ is in its simplest form, and represents the lowest terms of both $\frac{12}{16}$ and $\frac{6}{8}$. To obtain $\frac{3}{4}$ from these we divide Numerator and Denominator of the fractions by 4 and 2 respectively.

It is true universally that *the Numerator and Denominator of a Fraction may be divided or multiplied by the same number without altering the value.*

Ex. 1. Reduce $\frac{78}{104}$ to lowest terms.

$$\frac{78}{104} = \frac{2 \cdot 3 \cdot 13}{2 \cdot 2 \cdot 2 \cdot 13}.$$

We can divide top and bottom by 2 and 13, obtaining $\frac{3}{4}$.

Note that 2×13 is the H.C.F. of Numerator and Denominator.

Learn.

A Fraction is reduced to lowest terms by dividing Numerator and Denominator by the H.C.F. of these numbers.

Ex. 2. Reduce $\frac{17823}{37017}$ to lowest terms.

$$\begin{array}{r|l} 17823 & 37017 \\ 1371 & 35646 \\ \hline 4113 & 1371 \\ 4113 & \\ \hline \end{array}$$

$$\frac{17823}{37017} = \frac{1371 \times 13}{1371 \times 27} = \frac{13}{27}.$$

24. Addition of Fractions.

Consider how half-pence and farthings are added:

$$\begin{aligned} & \frac{1}{2}d. + \frac{3}{4}d. \\ &= 2 \text{ farthings} + 3 \text{ farthings} \\ &= 5 \text{ farthings} \\ &= 1\frac{1}{4}d., \text{ or one and a quarter units in pence.} \end{aligned}$$

We were able to add these fractions of a penny because we brought them to the same kind of thing, or, as we say, the same *denomination*, viz. quarters of the unit.

Again:

$$\begin{aligned} & \pounds\frac{3}{4} + \pounds\frac{2}{5} \quad \text{or} \quad \pounds\frac{3}{4} + \pounds\frac{2}{5} \\ &= 15s. + 8s. \quad = \pounds\frac{15}{20} + \pounds\frac{8}{20} \\ &= 23s. \quad = \pounds\frac{23}{20} \\ &= \pounds 1. 3s. \quad = \pounds 1\frac{3}{20}. \end{aligned}$$

Here again we have brought our fractions of a £ to the same denomination, viz. shillings or twentieths.

The same principle is used in adding any fractions, for we first change them to fractions having the same denominator. The denominator chosen is the L.C.M. of all the denominators, or the *Lowest Common Denominator*.

Ex. 1. $\frac{5}{12} + \frac{7}{18}$.

L.C.M. of denominators = 36,

$$\begin{aligned} \therefore \frac{5}{12} + \frac{7}{18} \\ &= \frac{15}{36} + \frac{14}{36} \\ &= \frac{29}{36}. \end{aligned}$$

Ex. 2. $3\frac{5}{6} + 4\frac{5}{9} + 2\frac{3}{4}$.

L.C.D. = 36.

Add whole numbers first.

$$\begin{aligned} \text{Expression} &= 9 + \frac{30}{36} + \frac{20}{36} + \frac{27}{36} \\ &= 9 + \frac{30 + 20 + 27}{36} \\ &= 9 + \frac{77}{36} \\ &= 9 + 2\frac{5}{36} = 11\frac{5}{36}. \end{aligned}$$

This is usually written as follows:

$$3\frac{5}{6} + 4\frac{5}{9} + 2\frac{3}{4} = 9\frac{30 + 20 + 27}{36} = 9\frac{77}{36} = 11\frac{5}{36}.$$

25. Subtraction of Fractions.

The method corresponds to that used in addition of fractions.

$$\text{Ex. 1. } \frac{3}{4} - \frac{2}{3} = \frac{9-8}{12} = \frac{1}{12}.$$

$$\text{Ex. 2. } 3\frac{9}{14} - 2\frac{11}{21} = 1\frac{27-22}{42} = 1\frac{5}{42}.$$

$$\text{Ex. 3. } 5\frac{1}{5} - 2\frac{11}{12} = 3\frac{12-55}{60}.$$

55 is more than 12. Hence we must change one of the three units into sixtieths. $1 = \frac{60}{60}$.

$$\therefore 3\frac{12-55}{60} = 2\frac{72-55}{60} = 2\frac{17}{60}.$$

EXERCISE 10 (a). MENTAL.

1. Change to improper fractions:

$$(a) 3\frac{3}{4}. \quad (b) 5\frac{1}{6}. \quad (c) 7\frac{2}{11}. \quad (d) 15\frac{3}{8}. \\ (e) 22\frac{9}{10}. \quad (f) 303\frac{5}{7}. \quad (g) 2001\frac{7}{9}. \quad (h) 1573\frac{10}{11}.$$

2. Change to mixed numbers:

$$(a) \frac{17}{4}. \quad (b) \frac{11}{5}. \quad (c) \frac{35}{17}. \quad (d) \frac{291}{24}. \\ (e) \frac{56}{15}. \quad (f) \frac{73}{19}. \quad (g) 4\frac{001}{20}. \quad (h) \frac{3573}{3572}.$$

3. Reduce to lowest terms:

$$(a) \frac{15}{18}. \quad (b) \frac{27}{36}. \quad (c) \frac{34}{36}. \quad (d) \frac{25}{45}. \\ (e) \frac{108}{120}. \quad (f) \frac{65}{104}. \quad (g) \frac{35}{84}. \quad (h) \frac{96}{108}.$$

4. Bring to equivalent fractions having the denominators indicated in brackets:

$$(a) \frac{7}{9} [36]. \quad (b) \frac{2}{3} [27]. \quad (c) \frac{5}{6} [120]. \quad (d) \frac{7}{8} [72].$$

Add:

$$5. \frac{2}{19} + \frac{1}{19} + \frac{6}{19} + \frac{5}{19}. \quad 6. \frac{1}{2} + \frac{3}{4} + \frac{6}{8}. \\ 7. \frac{3}{5} + \frac{9}{10}. \quad 8. \frac{4}{7} + \frac{3}{14}. \\ 9. 1\frac{1}{2} + 3\frac{1}{8}. \quad 10. 2\frac{2}{3} + 1\frac{1}{2}.$$

Subtract:

$$11. \frac{3}{8} - \frac{1}{4}. \quad 12. 1 - \frac{1}{3}. \\ 13. \frac{3}{5} - \frac{1}{10}. \quad 14. 1 - \frac{5}{6}. \\ 15. 1\frac{9}{18} - \frac{7}{8}. \quad 16. \frac{2}{3} - \frac{1}{4}. \\ 17. 2\frac{2}{3} - \frac{3}{4}. \quad 18. 1\frac{1}{6} - \frac{3}{4}.$$

Simplify:

- | | |
|--|--|
| 19. $\pounds\frac{1}{3} + \pounds\frac{1}{4} + \pounds\frac{1}{2}$. | 20. $\frac{2}{5}$ ton + $\cdot 5$ ton + 3 cwt. |
| 21. $\cdot 25$ yd. + $\frac{3}{4}$ yd. + 9 in. | 22. $\pounds 1 - \pounds 375$. |
| 23. 1·5 tons - 17 cwt. | 24. 3·5 lb. - 37 oz. |

EXERCISE 10 (b).

- Reduce to lowest terms:
 (a) $\frac{912}{1216}$. (b) $\frac{868}{1302}$. (c) $\frac{2184}{2808}$. (d) $\frac{864}{1296}$. (e) $\frac{1650}{1925}$.
- Change to mixed numbers and reduce to lowest terms:
 (a) $\frac{768}{43}$. (b) $\frac{812}{76}$. (c) $\frac{927}{81}$. (d) $\frac{512}{168}$. (e) $\frac{732}{18}$.
- $3\frac{2}{3} + 2\frac{3}{4}$. 4. $3\frac{2}{3} - 2\frac{3}{4}$.
- $5\frac{1}{4} + 1\frac{1}{6}$. 5. $5\frac{1}{4} - 1\frac{5}{6}$.
- $2\frac{1}{2} + 1\frac{1}{3} + 2\frac{1}{6}$. 6. $2\frac{1}{2} + 1\frac{1}{3} - 2\frac{1}{6}$.
- $2\frac{1}{2} - 1\frac{2}{3} + 2\frac{1}{6}$. 7. $2\frac{1}{2} - (2\frac{1}{6} - 1\frac{1}{3})$.
- $2\frac{1}{3} + 4\frac{1}{3} - 1\frac{1}{2}$. 8. $2\frac{2}{3} - \frac{2}{3} - \frac{5}{8}$.
- $4\frac{1}{5} + 3\frac{1}{3} + 2\frac{7}{30}$. 9. $1\frac{2}{5} - \frac{7}{9} + \frac{1}{15}$.
- $(1\frac{1}{9} + \frac{1}{3}) - (1\frac{1}{9} - \frac{1}{3})$. 10. $\frac{1}{10} + \frac{1}{5} + \frac{1}{2} - (\frac{1}{5} - \frac{1}{2})$.
- $7\frac{3}{4} - 1\frac{1}{2} + 3\frac{7}{10}$. 11. $2\frac{3}{4} + \frac{5}{8} - \frac{1}{12} + 2\frac{1}{2}$.
- $7 - (\frac{2}{3} + 1\frac{1}{2} + 3\frac{5}{6})$. 12. $45\frac{2}{3} + 173\frac{1}{6} - 200\frac{3}{4}$.

EXERCISE 10 (c).

- If I spend $\frac{1}{3}$ of my money in one shop and $\frac{1}{6}$ in another, what fraction have I left?
- Find the difference between $3\frac{1}{3}$ and $2\frac{1}{2}$.
- A schoolboy's 12-inch rule has $\frac{1}{4}$ inch to spare at each end. If $3\frac{1}{2}$ inches are cut off, how long is the remainder?
- $\frac{2}{3}$ of a pole is above ground and 4 feet are below ground. What is the length of the pole?
- After spending $\frac{2}{3}$ and $\frac{1}{4}$ of my money I have £30 left. What did I spend?
- I walk $\frac{1}{5}$ of my journey, travel by train for 30 miles and then take a taxi for the remaining $\frac{1}{10}$. How long is the journey?

7. If I read $\frac{3}{5}$ of a book of 600 pages on one day and 100 pages the next day, what fraction remains to be read?

8. A man divided his estate of £12,000 among his three sons. If the first had $\frac{2}{3}$ and the second $\frac{1}{6}$, how many pounds did the third receive?

9. If $5\frac{3}{4} + 1\frac{2}{5} - 3\frac{1}{10} = x - 2\frac{4}{5}$, find x .

10. A certain mixture of whisky and water contains $\frac{3}{5}$ whisky and $\frac{2}{5}$ water. If I add half a gallon of water to $2\frac{1}{2}$ gallons of the mixture, how much more water than whisky is there in the new mixture?

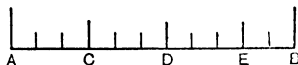
11. Find the sum of $3\frac{5}{8}$ sovereigns, $9\frac{3}{7}$ guineas and $2\frac{4}{5}$ half-crowns.

12. From a cask containing $2\frac{1}{2}$ gallons of water I draw off half a pint and then add $2\frac{1}{2}$ quarts. How many pints remain?

VULGAR FRACTIONS

MULTIPLICATION AND DIVISION. MIXED FRACTIONS.

26. Multiplication of a Fraction by a Whole Number.

Ex. 1. $\frac{3}{11} \times 3$.

Suppose the unit AB to be divided into 11 equal parts. AC contains 3 of the equal parts. $\therefore AC = \frac{3}{11}$.

Take 3 of the distances equal to AC , i.e. AE .

AE is found to contain 9 of the 11 sections. $\therefore AE = \frac{9}{11}$.

$$\text{I.e. } \frac{3}{11} \times 3 = \frac{9}{11}.$$

Ex. 2. $\frac{7}{12} \times 6$.

Here the unit is divided into 12 equal parts and 7 of them are taken to make $\frac{7}{12}$.

If we multiply this by 6 we get 42 twelfths.

$$\therefore \frac{7}{12} \times 6 = \frac{42}{12}.$$

This can be simplified to the form $3\frac{6}{12}$ or $3\frac{1}{2}$.

$$\text{Note that } \frac{7}{12} \times 6 = \frac{7 \times 6}{12}.$$

But since we can divide top and bottom by the same number

$$\frac{7 \times \cancel{6}}{\cancel{12}_2} = \frac{7}{2} = 3\frac{1}{2}.$$

$$\text{Ex. 3. } 3\frac{5}{6} \times 8 = \frac{23}{\cancel{6}_3} \times \cancel{8}_3 = 22 = 30\frac{2}{3}.$$

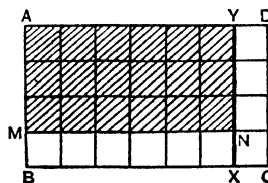
27. Multiplication of a Fraction by a Fraction.

Ex. 1. $\frac{3}{4} \times \frac{6}{7}$ or $\frac{3}{4}$ of $\frac{6}{7}$.

Divide the rectangle $ABCD$, in which $AD = 7$ units and $AB = 4$ units, into 28 equal squares. Then $ABXY = \frac{6}{7}$ of that unit.

$$AMNY = \frac{3}{4} \text{ of } ABXY.$$

$$\therefore AMNY = \frac{3}{4} \text{ of } \frac{6}{7}.$$



But $AMNY$ contains 18 of the 28 equal squares.

$$\therefore \frac{3}{4} \times \frac{6}{7} = \frac{18}{28}.$$

I.e. we multiply together the Numerators to form the new Numerator, and the Denominators to form the new Denominator.

Finally the fraction is reduced to lowest terms.

$$\frac{3}{4} \times \frac{6}{7} = \frac{9}{14}.$$

$$\text{Ex. 2. } 3\frac{5}{9} \times 4\frac{1}{8} = \frac{32}{9} \times \frac{33}{8} = \frac{44}{3} = 14\frac{2}{3}.$$

$$\text{Ex. 3. } 3\frac{2}{3} \times 2\frac{1}{2} \times 4\frac{1}{5} = \frac{11}{3} \times \frac{5}{2} \times \frac{21}{5} = \frac{77}{2} = 37\frac{1}{2}.$$

28. Division of a Fraction by a Whole Number.

$$\text{Ex. 1. } \frac{3}{5} \div 2.$$

$$ABXY = \frac{3}{5} \text{ of } ABCD.$$

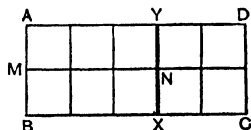
$$AMNY \text{ represents } \frac{3}{5} \div 2$$

$$\text{i.e. } \frac{3}{5} \times \frac{1}{2}.$$

$$\text{But } AMNY = \frac{3}{10}.$$

$$\therefore \frac{3}{5} \div 2 = \frac{3}{5} \times \frac{1}{2} = \frac{3}{10}.$$

$$\text{Ex. 2. } 5\frac{5}{8} \div 10 = \frac{45}{8} \times \frac{1}{10} = \frac{9}{16}.$$



29. Division of a Fraction by a Fraction.

$$\text{Ex. 1. } \frac{3}{5} \div \frac{6}{8}.$$

$$\text{Let } \frac{3}{5} \div \frac{6}{8} \text{ be represented by } \frac{3}{5}.$$

We can multiply *top and bottom* by any number. Use the number 40.

$$\text{Then } \frac{3}{5} = \frac{3 \times 40}{5 \times 40} = \frac{24}{30}.$$

$$\text{But } \frac{3}{5} \times \frac{8}{6} = \frac{24}{30}. \therefore \frac{3}{5} \div \frac{6}{8} = \frac{3}{5} \times \frac{8}{6}.$$

Hence *to divide a fraction by a proper or improper fraction, we invert the divisor and multiply.*

$$\text{Ex. 2. } 12\frac{2}{3} \div 4\frac{3}{4} = \frac{38}{3} \div \frac{19}{4} = \frac{38}{3} \times \frac{4}{19} = \frac{8}{3} = 2\frac{2}{3}.$$

$$\text{Ex. 3. } 3\frac{1}{2} \times 2\frac{1}{4} \div \frac{5}{8} = \frac{7}{2} \times \frac{9}{4} \times \frac{8}{5} = \frac{63}{5} = 12\frac{3}{5}.$$

30. Mixed Fractions.

$$\begin{aligned}
 \text{Ex. 1. } & \frac{2\frac{1}{6} + 2\frac{5}{8}}{4\frac{1}{9} - 2\frac{5}{8}} \\
 & \frac{4\frac{4+15}{24}}{2\frac{2-15}{18}} \\
 & = \frac{4\frac{19}{24}}{1\frac{5}{18}} \\
 & = \frac{5}{4} \times \frac{3}{23} \\
 & = \frac{15}{4} \\
 & = 3\frac{3}{4}.
 \end{aligned}$$

$$\begin{aligned}
 \text{Ex. 2. } & \frac{3}{8} + 1\frac{5}{2} - (\frac{3}{4} \text{ of } \frac{16}{27}) \\
 & = \frac{9+10}{24} - \frac{3}{4} \times \frac{4}{27} \\
 & = \frac{19}{24} - \frac{4}{9} \\
 & = \frac{57-32}{72} \\
 & = \frac{25}{72}.
 \end{aligned}$$

$$\begin{aligned}
 \text{Ex. 3. } & 2\frac{2}{3} - 2\frac{1}{2} \div 3\frac{1}{3} \text{ of } 2\frac{1}{4}. \\
 & \text{(See below)}
 \end{aligned}$$

Note:

1. Quantities joined by the word "of" must be multiplied together before any other operations are performed upon them. They may always be assumed to be within brackets.

2. Quantities joined by the sign \div are also intimately connected; and the divisor must be inverted, and the operation completed, before addition and subtraction signs are dealt with.

Hence the order is: (1) "of", (2) \div , (3) \times , (4) $+$ and $-$.

$$\begin{aligned}
 \therefore & 2\frac{2}{3} - 2\frac{1}{2} \div 3\frac{1}{3} \text{ of } 2\frac{1}{4} \\
 & = 2\frac{2}{3} - 2\frac{1}{2} \div (\frac{3}{3} \times \frac{5}{2}) \\
 & = 2\frac{2}{3} - 2\frac{1}{2} \div \frac{15}{2} \\
 & = 2\frac{2}{3} - (\frac{5}{2} \times \frac{2}{15}) = 2\frac{2}{3} - \frac{1}{3} = 2\frac{1}{3}.
 \end{aligned}$$

EXERCISE 11 (a). MENTAL.

- | | | |
|--|---|---|
| 1. $\frac{2}{13} \times 4$. | 2. $\frac{5}{11} \times 2$. | 3. $\frac{15}{59} \times 3$. |
| 4. $\frac{2}{17} \times 8$. | 5. $\frac{3}{5} \times \frac{1}{3}$. | 6. $\frac{10}{23} \times \frac{1}{5}$. |
| 7. $\frac{5}{6} \times 3$. | 8. $\frac{7}{12} \times 4$. | 9. $\frac{2}{3} \times \frac{4}{5}$. |
| 10. $\frac{5}{6} \times \frac{3}{10}$. | 11. $\frac{1}{2}$ of $\frac{5}{9}$. | 12. $\frac{2}{3}$ of $\frac{4}{9}$. |
| 13. $1\frac{1}{2} \times 1\frac{1}{3}$. | 14. $2\frac{1}{2} \times \frac{4}{5}$. | 15. $1\frac{2}{3} \times \frac{3}{5}$. |
| 16. $2\frac{1}{2} \times \frac{2}{5}$. | 17. $\frac{2}{3} \div 2$. | 18. $\frac{4}{5} \div 4$. |
| 19. $1\frac{1}{2} \div 3$. | 20. $5 \div 2\frac{1}{2}$. | 21. $3\frac{3}{4} \div 2\frac{1}{2}$. |
| 22. $2\frac{1}{2} \div \frac{5}{6}$. | 23. $5\frac{1}{5} \div 2\frac{3}{5}$. | 24. $5 \div \frac{1}{5}$. |

EXERCISE 11 (b).

- | | | |
|--|---|---|
| 1. $5\frac{5}{6} \times 3\frac{1}{7}$. | 2. $3\frac{3}{4} \times 2\frac{2}{15}$. | 3. $5\frac{1}{2} \times \frac{7}{22}$. |
| 4. $3\frac{1}{2} \times 2\frac{5}{8} \times 4\frac{2}{7}$. | 5. $1\frac{7}{8} \times \frac{3}{10} \times 1\frac{3}{4}$. | |
| 6. $3\frac{3}{14} \times 1\frac{7}{15} \times \frac{7}{33}$. | 7. $10\frac{1}{2} \times 4\frac{4}{15} \times 3\frac{1}{7} \times \frac{5}{8}$. | |
| 8. $1\frac{7}{8} \times 3\frac{3}{4} \times 2\frac{1}{3}$. | 9. $1\frac{7}{8} \times 2\frac{5}{8} \times \frac{20}{33}$. | |
| 10. $1\frac{7}{8} \div 1\frac{1}{3}$. | 11. $3\frac{3}{4} \div 5\frac{5}{6}$. | 12. $7\frac{5}{8} \div 12\frac{1}{6}$. |
| 13. $3\frac{1}{3} + 2\frac{1}{5}$ of $3\frac{1}{3}$. | 14. $2\frac{1}{4} - \frac{2}{3}$ of $1\frac{5}{6}$. | |
| 15. $(5\frac{2}{7} \div 7\frac{2}{5}) + 1\frac{4}{7}$. | 16. $4\frac{1}{9} \div (\frac{1}{8} - \frac{1}{9})$. | |
| 17. $(\frac{5}{12} + \frac{9}{20}) \div \frac{7}{15}$. | 18. $\frac{5}{12}$ of $\frac{9}{20} - \frac{7}{15}$. | |
| 19. $\frac{1}{4} \times \frac{1}{6} - \frac{1}{12} \times \frac{1}{6}$. | 20. $(\frac{3}{4} - \frac{2}{3})(\frac{4}{5} - \frac{2}{3})$. | |
| 21. $(2\frac{1}{3} - \frac{2}{7}) \times \frac{9}{17} - \frac{58}{119}$. | 22. $(\frac{1}{4} + \frac{1}{5} + \frac{1}{6}) \div (\frac{1}{8} + \frac{1}{9} + \frac{1}{10})$. | |
| 23. $\frac{2}{3}(\frac{1}{2} + \frac{5}{6}) + \frac{4}{7} \times 4\frac{1}{5}$. | 24. $4\frac{3}{4} - \frac{2}{3}$ of $5\frac{2}{3}$. | |
| 25. $\frac{1}{9}(1\frac{1}{3} + \frac{1}{3}) \div (\frac{1}{10} \times \frac{1}{5} + \frac{1}{2})$. | 26. $\frac{1}{7} \times (\frac{1}{8} + \frac{1}{4}) \div \frac{1}{9}$ of $(\frac{2}{7} - \frac{1}{4})$. | |
| 27. $\frac{1}{2} \times \frac{9}{13} + \frac{1}{3} \div 2\frac{3}{5}$. | 28. $\frac{3}{13} \times \frac{1}{4} - \frac{1}{3} \div 6\frac{1}{2}$. | |
| 29. $(1\frac{1}{2} \times 2\frac{1}{2}) - (1\frac{1}{3} \times 2\frac{1}{3})$. | 30. $(5\frac{3}{8} - 4\frac{5}{32}) \div (1\frac{5}{8}$ of $1\frac{1}{2})$. | |
| 31. $\frac{3}{4\frac{1}{2}} + \frac{5}{3\frac{1}{3}} + \frac{7}{2\frac{1}{3}}$. | 32. $\frac{1}{3\frac{1}{4}} + \frac{1}{10\frac{2}{5}} + \frac{1}{4\frac{1}{3}}$. | |
| 33. $(\frac{2}{3} + \frac{1}{6})^2$. | 34. $\frac{5\frac{3}{4} - 2\frac{1}{3}}{4\frac{1}{4} - 2\frac{2}{3}}$. | |
| 35. $\frac{\frac{1}{2}$ of $\frac{2}{3} \div \frac{1}{4}}{1\frac{3}{4} + \frac{2}{5}$ of $4\frac{1}{2}}$. | 36. $\frac{5\frac{3}{4} - 2\frac{1}{2} \div 3\frac{1}{3}}{(5\frac{3}{4} - 2\frac{1}{2}) \div 3\frac{1}{3}}$. | |

DECIMALS

MULTIPLICATION AND DIVISION.

31. Multiplication.(a) *Old Method.*

$$32\cdot56 \times \cdot0156.$$

$$32\cdot56 = 3256 \div 100.$$

$$\cdot0156 = 156 \div 1000000.$$

$$\therefore 32\cdot56 \times \cdot0156 = 3256 \times 156 \div 1000000.$$

In other words, multiply 3256 and 156 as if they were whole numbers, and divide the answer by 1000000.

Note that $32\cdot56$ has 2 places of decimals, and $\cdot0156$ has 4 places.

The above process is equivalent to counting back 6 places in the answer.

$$\begin{array}{r} 3256 \\ \quad 156 \\ \hline 325600 \\ 162800 \\ 19536 \\ \hline 507936 \end{array}$$

$$\begin{array}{l} 507936 \div 1000000 \\ = \cdot507936. \text{ Ans.} \end{array}$$

(b) *“Standard Form” Method.*

In using this method we *change the multiplier into a number having a unit figure followed by decimal places.*

$$\cdot0156 \text{ in Standard Form} = 1\cdot56.$$

We have multiplied $\cdot0156$ by 100, or moved the decimal point 2 places to the *right*. We must therefore divide $32\cdot56$ by 100, or move the decimal point 2 places to the *left*, i.e. $\cdot3256$.

$$\therefore 32\cdot56 \times \cdot0156$$

$$= \cdot3256 \times 1\cdot56.$$

$$\text{Rough answer} = 2 \text{ times } \cdot3 \text{ or } \cdot6 \text{ [or } 1\cdot6 \times \cdot3, \text{ i.e. } 4\cdot8].$$

$$\begin{array}{r} \cdot3256 \\ \quad 1\cdot56 \\ \hline \cdot3256 \\ 16280 \\ 19536 \\ \hline \cdot507936 \end{array}$$

Note that $\cdot 5079$ is correct to 4 places.

$\cdot 508$ to 3 places.

$\cdot 51$ to 2 places.

32. Division.

(a) *Old Method*, making divisor a whole number.

$$\cdot 005635 \div \cdot 157$$

$$= 5\cdot 635 \div 157.$$

$$\cdot 03589.$$

$$157 \overline{) 5\cdot 635}$$

$$\underline{4\ 71}$$

$$925$$

$$\underline{785}$$

$$1400$$

$$\underline{1256}$$

$$1440$$

157 will not divide into 5. Put a decimal point in the answer. Try 56. 157 will not divide into this. Put a 0 after the decimal point. Try 157 into 563 and proceed as usual, bringing down 0 when all figures have been used.

$$\cdot 005635 \div \cdot 157 = \cdot 03589, \text{ etc.}$$

$= \cdot 0359$ correct to 4 places or to three *significant* figures.

$= \cdot 036$ to 3 places or two significant figures.

$= \cdot 04$ to 2 places or one significant figure.

(b) "*Standard Form*" Method.

Here we *change the divisor into a number having a unit figure followed by decimal places.*

$$\cdot 005635 \div \cdot 157$$

$$= \cdot 05635 \div 1\cdot 57.$$

$$\text{Rough answer} = \cdot 05 \div 1\cdot 5 = \cdot 03, \text{ etc.}$$

$$\cdot 03589.$$

$$1\cdot 57 \overline{) 0\cdot 05635}$$

$$\underline{471}$$

$$925$$

$$\underline{785}$$

$$1400$$

$$\underline{1256}$$

$$1440$$

We know the rough answer is about $\cdot 03$. Try 3. 157 will go 3 times into 563. Hence put up $\cdot 03$ and proceed.

33. Learn.

$$\begin{aligned}
 (1) \quad & \cdot 25 = \frac{1}{4}, & \cdot 5 = \frac{1}{2}, & \cdot 75 = \frac{3}{4}. \\
 & \therefore \cdot 025 = \frac{1}{40}, & \cdot 005 = \frac{1}{200}, & \cdot 00075 = \frac{3}{4000}, \text{ etc.} \\
 (2) \quad & \cdot 125 = \frac{1}{8}, & \cdot 375 = \frac{3}{8}, & \cdot 625 = \frac{5}{8}, & \cdot 875 = \frac{7}{8}. \\
 & \therefore \cdot 0125 = \frac{1}{80}, & \cdot 00375 = \frac{3}{800}, & \cdot 000875 = \frac{7}{8000}, \text{ etc.}
 \end{aligned}$$

(3) In reducing to Standard Form the following principles are involved:

(a) *In Multiplication.*

If the multiplier is *multiplied* by a certain power of 10, the multiplicand must be *divided* by the same power of 10, and vice versa; for, in general,

$$x \times y = 10x \times \frac{y}{10}, \text{ or } = 100x \times \frac{y}{100}, \text{ or } = 1000x \times \frac{y}{1000}, \text{ etc.}$$

(b) *In Division.*

If the divisor is *multiplied* by a certain power of 10, the dividend must also be *multiplied* by the same power of 10. Similarly *both must be divided* by the same power of 10; for, in general,

$$x \div y = 10x \div 10y, \text{ or } = 100x \div 100y, \text{ or } = 1000x \div 1000y, \text{ etc.};$$

$$\text{also } x \div y = \frac{x}{10} \div \frac{y}{10}, \text{ or } = \frac{x}{100} \div \frac{y}{100}, \text{ or } = \frac{x}{1000} \div \frac{y}{1000}, \text{ etc.}$$

(4) *To reduce a proper fraction to a decimal, divide numerator by denominator.*

MISCELLANEOUS EXAMPLES IN DECIMALS.

$$34. \text{ Ex. 1. } \frac{\cdot 00281 \times \cdot 0625}{1 \cdot 405}.$$

Method 1.

It is clear that 1·405 will divide exactly into ·00281.

$$\cdot 00281 \div 1 \cdot 405 = \cdot 002.$$

$$\begin{aligned}
 \cdot 0625 \times \cdot 002 &= \cdot 0000625 \times 2 \\
 &= \cdot 000125.
 \end{aligned}$$

Method 2.

$$\frac{\cdot 00281 \times \cdot 0625}{1 \cdot 405} = \frac{\cancel{281} \times \cancel{625}}{1405} \times \frac{5}{80} \times \frac{10000}{\cancel{1405}} = \frac{1}{8000} = \cdot 000125.$$

Method 3.

$$\cdot 00281 \times \cdot 0625 = \cdot 0000281 \times 6 \cdot 25. \quad 1 \cdot 405) \cdot 000175625 (\cdot 000125$$

$$\cdot 0000281$$

$$\underline{1405}$$

$$\underline{6 \cdot 25}$$

$$\underline{3512}$$

$$\cdot 0001686$$

$$\underline{2810}$$

$$562$$

$$\underline{7025}$$

$$\underline{1405}$$

$$\underline{7025}$$

$$\cdot 000175625$$

$$\cdot 000175625 \div 1 \cdot 405.$$

Rough Answer = $\cdot 0001$.

$$\text{Ex. 2. } \frac{63 - 0 \cdot 63 + 0 \cdot 255}{4 \cdot 72 - 3 \cdot 05} = \frac{63 \cdot 255 - \cdot 63}{1 \cdot 67} = \frac{62 \cdot 625}{1 \cdot 67}, \text{ etc.}$$

$$\text{Ex. 3. } \frac{\cdot 013 \times \cdot 119}{\cdot 136 \times \cdot 091}$$

$$= \frac{\overset{11}{13} \times \overset{11}{119}}{\overset{8}{136} \times \overset{91}{091}}$$

(Note that we multiply top and bottom by 1000×1000 .)

$$= \frac{1}{8} \text{ or } \cdot 125.$$

EXERCISE 12 (a). MENTAL.1. Change to simple fractions $\cdot 9$, $\cdot 6$, $\cdot 75$, $\cdot 05$, $\cdot 0025$.2. Change to decimals $\frac{3}{8}$, $\frac{7}{10}$, $\frac{7}{8}$, $\frac{3}{40}$, $\frac{3}{80}$.

Reduce to Standard Form:

3. $56 \cdot 15 \div 48 \cdot 27$.

4. $49 \cdot 34 \times 45 \cdot 16$.

5. $\cdot 0387 \div \cdot 00165$.

6. $\cdot 0573 \times \cdot 0285$.

7. $1 \cdot 539 \times 482 \cdot 5$.

8. $3 \cdot 472 \times 439 \cdot 4$.

9. $\cdot 0000578 \times 5640000$.

10. $\cdot 0003859 \div \cdot 0000598$.

Write down the answers to the following:

11. $\cdot 1 \times \cdot 1$.

12. $\cdot 2 \times \cdot 3$.

13. $\cdot 5 \times \cdot 4$.

14. $\cdot 02 \times 6$.

15. $\cdot 05 \div 5$.

16. $\cdot 05 \div \cdot 5$.

17. $5 \div 200$.

18. $\cdot 15 \times \cdot 5$.

19. $(\cdot 5)^2$.

20. $5 \times (\cdot 2)^2$.

EXERCISE 12 (b).

Multiplication:

- | | |
|--------------------------------------|--------------------------------------|
| 1. $486 \times \cdot 00365$. | 2. $37\cdot 5 \times \cdot 0863$. |
| 3. $5\cdot 27 \times \cdot 685$. | 4. $\cdot 5136 \times \cdot 00853$. |
| 5. $\cdot 002641 \times \cdot 016$. | 6. $\cdot 0008357 \times 564$. |
| 7. $5629 \times \cdot 000387$. | 8. $46375 \times \cdot 000035$. |
| 9. $\cdot 156 \times \cdot 371$. | 10. $(\cdot 025)^2$. |

Division:

- | | |
|--------------------------------------|-----------------------------|
| 11. $587 \div 483$ | <i>correct to 2 places.</i> |
| 12. $512\cdot 4 \div 4\cdot 76$ | „ 2 „ |
| 13. $46\cdot 35 \div 34\cdot 7$ | „ 3 „ |
| 14. $4\cdot 587 \div 1\cdot 385$ | „ 2 „ |
| 15. $5\cdot 1082 \div \cdot 0398$ | „ 2 „ |
| 16. $47\cdot 352 \div \cdot 359$ | „ 1 place. |
| 17. $\cdot 2571 \div \cdot 135$ | „ 2 places. |
| 18. $\cdot 00839 \div \cdot 057$ | „ 3 „ |
| 19. $\cdot 05793 \div 2\cdot 36$ | „ 4 „ |
| 20. $\cdot 0000516 \div \cdot 00364$ | „ 4 „ |

Change to Decimals *correct to 3 places*:

21. $\frac{56}{341}$. 22. $\frac{49}{378}$. 23. $\frac{1}{356}$. 24. $\frac{25}{3}$. 25. $\frac{17}{3985}$.
26. $(3\cdot 8 - \cdot 612) \div 79\cdot 7$. 27. $\frac{15\cdot 036 - 7\cdot 9456}{\cdot 025}$.
28. $\frac{\cdot 1875 \times 32\cdot 4}{\cdot 0675}$. 29. $\frac{2\cdot 25 \times 1\cdot 96}{1\cdot 4 \times 1\cdot 5}$.
30. $\frac{4\cdot 76 + 3\cdot 028 + 17\cdot 087}{1\cdot 25}$.
31. $\frac{7\cdot 64 + 20\cdot 2516 - 3\cdot 8}{2\cdot 05 \times 1\cdot 13}$ (to 1 place).
32. $\cdot 0425 \times 27\cdot 8 - \frac{\cdot 9516}{10\cdot 4}$. 33. $\frac{\cdot 8}{\cdot 025} + \frac{\cdot 025}{\cdot 8}$
34. $\frac{5\cdot 1}{85} - \frac{3\cdot 9}{260}$. 35. $(\cdot 6)^3 + (\cdot 2)^3 - (\cdot 4)^3$.

SQUARE ROOT

35. The *Square Root* of a number is a number which, if multiplied by itself, gives the original number, e.g. $8 \times 8 = 64$; \therefore 8 is the *square root* of 64, and 64 is the *square* of 8. Similarly the square root of .09 is .3, because $.3 \times .3 = .09$.

The square root of a number is indicated by means of a *root sign* placed to the left and above it; thus the square root of 8 is written $\sqrt{8}$.

Similarly the *cube root* of 8 is written $\sqrt[3]{8}$; the *fourth root* of 256 is written $\sqrt[4]{256}$.

$$\sqrt[3]{8} = 2, \text{ because } 2 \times 2 \times 2 \text{ (3 factors)} = 8.$$

$$\sqrt[4]{256} = 4, \text{ because } 4 \times 4 \times 4 \times 4 = 256.$$

The square roots of such numbers as 4, 9, 16, 25, etc. can be exactly determined, because these are perfect squares; but the square roots of 2, 3, 5, 8, etc. can only be determined approximately.

36. Finding Square Roots.

(a) *By Prime Factors.*

$$\text{Ex. 1. } \sqrt{144} = \sqrt{2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3} = \sqrt{2^4 \cdot 3^2} = 2^2 \cdot 3 = 12.$$

$$\text{Ex. 2. } \sqrt{1764} = \sqrt{2 \cdot 2 \cdot 3 \cdot 3 \cdot 7 \cdot 7} = \sqrt{2^2 \cdot 3^2 \cdot 7^2} = 2 \cdot 3 \cdot 7 = 42.$$

In each case we take one of each pair of equal factors.

(b) *By the "long" method.*

Ex. 1. Find the square root of 157609.

$$\begin{array}{r} 15 \overline{) 76 \mid 09 \text{ (397)}} \\ \underline{9} \\ 69 \overline{) 676} \\ \underline{621} \\ 787 \overline{) 5509} \\ \underline{5509} \end{array} \quad \text{Sq. Rt.} = 397.$$

Step 1. Mark off the figures in groups of two, starting from the decimal point.

Step 2. Find the nearest square less than 15, place it under the 15 and subtract. Bring down the next group, giving 676.

Step 3. The square root of 9 is 3. Place the 3 in the quotient, or answer space. Double it and place it as part of the new divisor as shown (namely 6).

Step 4. By the side of the figure 6 place such a number (here 9) that when the new divisor is multiplied by that number the result is equal to or just less than the 1st remainder, i.e. $69 \times 9 = 621$, which is just less than 676. Subtract, and bring down the next group, giving 5509.

Step 5. Double the part of the answer now obtained (i.e. 39) and place 78 as part of the new divisor.

Step 6. Repeat step 4. 787×7 is just equal to 5509. This completes the process.

Ex. 2. Find the square root of 396.5 to the nearest second place of decimals.

$$\begin{array}{r}
 3 \overline{) 96.50} \mid 00 \mid 00 \quad (19.912 \\
 \underline{9} \\
 29 \\
 \underline{296} \\
 389 \\
 \underline{389} \\
 3981 \\
 \underline{3981} \\
 39822 \\
 \underline{39822} \\
 91900
 \end{array}$$

Sq. Rt. = 19.91 to two places.

Notice that we must carry the answer to three places in order to get the second place correct to the nearest figure.

37. Application to problems.

Ex. 1. Find the side of the square field which has an area of 10 acres.

$$10 \text{ acres} = 48400 \text{ sq. yd.}$$

$$\sqrt{48400} = 220.$$

\therefore the side is 220 yd. or 1 furlong.

Ex. 2. A rectangle of area 97.8123 square feet has one side three times as long as the other. Find the lengths of the sides.

The rectangle can be divided into three equal squares.

Area of one square = $\frac{1}{3}$ of 97·8123

$$= 32\cdot6041.$$

$$\sqrt{32\cdot6041} = 5\cdot71 \text{ (found by the "long" method).}$$

\therefore one side = 5·71 ft.)

the other = 17·13 ft.)

Ex. 3. Two sides of a right-angled triangle are 4·1" and 5·1". Find the length of the longest side, or *hypotenuse* (i.e. the side opposite to the right angle).

The sides of a right-angled triangle are such that *the square on the hypotenuse is equal to the sum of the squares on the other two sides*.

Let a , b and c be the sides, c being the hypotenuse.

$$\begin{aligned}\therefore c^2 &= a^2 + b^2 \\ &= (4\cdot1)^2 + (5\cdot1)^2 \\ &= 16\cdot81 + 26\cdot01 \\ &= 42\cdot82. \\ \therefore c &= \sqrt{42\cdot82} \\ &= 6\cdot5'' \text{ approximately.}\end{aligned}$$

EXERCISE 13 (a). MENTAL.

Give the square roots of the following numbers:

- | | | | | |
|---------|---------|---------|------------|----------------|
| 1. 16. | 2. 25. | 3. 81. | 4. 100. | 5. 144. |
| 6. 256. | 7. 729. | 8. 576. | 9. 40,000. | 10. 1,210,000. |

Write down the square roots of:

- | | | |
|-----------------------------|-------------------------------|--------------------------------|
| 11. $4 \times 9 \times 9$. | 12. $9 \times 16 \times 25$. | 13. $4 \times 100 \times 16$. |
|-----------------------------|-------------------------------|--------------------------------|

Give approximately the values of:

- | | | |
|---------------------------|---------------------------|----------------------------|
| 14. $\sqrt{15\cdot987}$. | 15. $\sqrt{0\cdot9026}$. | 16. $\sqrt{0\cdot39985}$. |
|---------------------------|---------------------------|----------------------------|

EXERCISE 13 (b).

Find the square roots of the following numbers:

- | | | | |
|--------------|--------------|--------------|--------------|
| 1. 1849. | 2. 6084. | 3. 8281. | 4. 11,025. |
| 5. 19,044. | 6. 21,316. | 7. 33,124. | 8. 54,756. |
| 9. 79,524. | 10. 142,884. | 11. 224,676. | 12. 443,556. |
| 13. 31·36. | 14. 299·29. | 15. 3·3124. | 16. 1421·29. |
| 17. ·217156. | 18. ·191844. | 19. ·151321. | 20. 17·3889. |

In the following give the answers correct to three places of decimals:

- | | | | |
|---------------------|---------------------|----------------------|---------------------|
| 21. $\sqrt{440}$. | 22. $\sqrt{570}$. | 23. $\sqrt{666}$. | 24. $\sqrt{59}$. |
| 25. $\sqrt{2}$. | 26. $\sqrt{5}$. | 27. $\sqrt{14}$. | 28. $\sqrt{80}$. |
| 29. $\sqrt{0106}$. | 30. $\sqrt{2561}$. | 31. $\sqrt{19876}$. | 32. $\sqrt{4145}$. |

EXERCISE 13 (c).

1. Find the length of a side of a square of which the area is 6 sq. ft. 36 sq. in.
2. The sides of a right-angled triangle are 5 and 12 inches long. Find the length of the hypotenuse.
3. The distance between opposite corners of a floor is 26 feet and the breadth of the room is 10 feet. Find its length.
4. How long is the diagonal of a square if the length of one side is $1\frac{1}{2}$ inches? Give the answer correct to the nearest tenth of an inch.
5. One side of a rectangle is twice the other, and the area is 69 square inches. Find the length of the shorter side correct to the nearest tenth of an inch.
6. What number has a square root of 5.05?
7. The area of a circle is found from the formula $A = \pi r^2$, where $\pi =$ approximately $3\frac{1}{7}$. If the area of a circle is 124.74 square inches, what is the length of the radius?
8. A ladder 25 feet long just reaches a window 20 feet above the ground. How far out is its foot?

FRACTIONS AND DECIMALS OF CONCRETE QUANTITIES

38. Ex. 1. Bring 3 yd. 2 ft. 9 in. to the fraction of 7 yd. 2 ft. 3 in.

Reduce both quantities to a convenient unit, here quarter-feet.

$$3 \text{ yd. } 2 \text{ ft. } 9 \text{ in.} = 11\frac{3}{4} \text{ ft.}$$

$$7 \text{ yd. } 2 \text{ ft. } 3 \text{ in.} = 23\frac{1}{4} \text{ ft.}$$

$$\text{Fraction} = \frac{11\frac{3}{4}}{23\frac{1}{4}} = \frac{47}{93}.$$

Ex. 2. Simplify $\frac{1}{11}$ of 5s. 6d. + $\frac{1}{37}$ of 10s. 9½d.

$$\text{Expression} = \frac{1}{11} \times 11 \text{ sixpences} + \frac{1}{37} \times 129\frac{1}{2}d.$$

$$= 5s. + \frac{11}{37} \times \frac{7}{2}d.$$

$$= 5s. + 3s. 2\frac{1}{2}d. = 8s. 2\frac{1}{2}d.$$

Ex. 3. Bring £3·690625 to £ s. d.

$$\begin{array}{r}
 3\cdot690625 \\
 \underline{20} \qquad \qquad \qquad \text{£3. } 13s. \ 9\frac{3}{4}d. \\
 13\cdot812500 \\
 \underline{12} \\
 9\cdot7500 \\
 \underline{4} \\
 3\cdot00
 \end{array}$$

Ex. 4. Express 12s. 9¾d. as a decimal of £1.

Method 1

$$\frac{12s. \ 9\frac{3}{4}d.}{\text{£1}} = \frac{153\frac{3}{4}}{240} = \frac{615}{960} = \frac{41}{64} = \text{£}\cdot640625.$$

Method 2.

$$12s. \ 9\frac{3}{4}d. = 12s. \ 9\cdot75d. = 12\cdot8125s. = \text{£}\cdot640625.$$

Note that 9·75d. is divided by 12 to bring to shillings: result ·8125. 12·8125s. is divided by 20 to bring to £.

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39. Reducing shillings and pence to the decimal of £1 correct to 3 places.

Express 17s. 5½d. as a decimal of £1 correct to 3 places.

Note that:

$$1s. = £\cdot05.$$

$$\frac{1}{4}d. = £\cdot001\frac{1}{4}.$$

But 3d. = £·012½, or approximately ·013.

$$8\frac{1}{4}d. = £\cdot035\frac{3}{4}; \text{ i.e. } £\cdot036\frac{1}{4}, \text{ or approximately } \cdot036.$$

$$9d. = £\cdot036\frac{3}{4}; \text{ i.e. } £\cdot037\frac{1}{4}, \text{ or approximately } \cdot038.$$

$$11\frac{3}{4}d. = £\cdot047\frac{1}{4}; \text{ i.e. } £\cdot048\frac{3}{4}, \text{ or approximately } \cdot049.$$

This gives us the method:

Call each shilling ·05.

Call each other farthing ·001 but add ·001 more if the farthings are between 12 and 35 (i.e. 3d. to 8¼d.) and ·002 more if the farthings are between 36 and 47 (i.e. over 9d.).

$$17s. 5\frac{1}{4}d. = 17s. + 23f. = £\cdot05 \times 17 + £\cdot001 \times 24 = £\cdot874.$$

$$5s. 7\frac{1}{4}d. = 5s. + 29f. = £\cdot25 + £\cdot001 \times 30 = £\cdot280.$$

$$12s. 10\frac{1}{2}d. = 12s. + 42f. = £\cdot6 + £\cdot001 \times 44 = £\cdot644.$$

40. Reducing decimals of £ to shillings and pence.

Ex. Bring £·917 to s. and d. to the *nearest penny*.

First find all multiples of ·05. Here ·917 = ·90 + ·017.

If we call ·017 4¼d., we shall assume that $17 \times \cdot001\frac{1}{4} = \cdot017$ to the nearest 3rd place. This is incorrect; it should be ·018.

Hence ·017 = 4d. or 16 farthings. The answer is 18s. 4d.

In general if the remainder is greater than ·012 we subtract 1 in order to find the number of farthings: e.g.

$$£\cdot826 = £(\cdot80 + \cdot026)$$

$$= 16s. 6d. \text{ to the nearest penny.}$$

$$£\cdot841 = £(\cdot80 + \cdot041)$$

$$= 16s. 10d. \text{ to the nearest penny.}$$

The following method may be preferred when mental working is not required:

| | | |
|--|--|--|
| $\begin{array}{r} \cdot 917 \\ \hline 20 \end{array}$ | $\begin{array}{r} \cdot 826 \\ \hline 20 \end{array}$ | $\begin{array}{r} \cdot 841 \\ \hline 20 \end{array}$ |
| $\begin{array}{r} 18 \cdot 340 \\ \hline 12 \end{array}$ | $\begin{array}{r} 16 \cdot 520 \\ \hline 12 \end{array}$ | $\begin{array}{r} 16 \cdot 820 \\ \hline 12 \end{array}$ |
| $\begin{array}{r} 4 \cdot 08 \\ \hline \end{array}$ | $\begin{array}{r} 6 \cdot 24 \\ \hline \end{array}$ | $\begin{array}{r} 9 \cdot 84 \\ \hline \end{array}$ |
| 18s. 4d. | 16s. 6d. | 16s. 10d. |

41. Rates of Exchange.

In order that trade and intercourse may be carried on between one country and another, it is necessary for merchants and travellers to know how much the units of coinage in their own country are worth when exchanged for those of another country.

The comparison, known as the *rate of exchange*, varies but slightly in normal times. Striking variations have, however, taken place since the Great War; e.g. a textbook of arithmetic written in 1906 gives the following equivalents as existing at that time:

French Franc. $25 \cdot 22\frac{1}{2}$ francs to the £.

At the present date (March 16, 1928) the following are the equivalents:

French Franc. 124 francs to the £.

Ex. If £1. 15s. is exchanged for French francs at the latter rate, how many francs will be obtained if the bank deducts 1 franc for every 100 or part of 100 changed?

$$£1 = 124 \text{ f.}$$

$$£1. 15s. = 217 \text{ f.}$$

$$\therefore 215 \text{ francs will be obtained.}$$

Foreign Exchanges will be considered in greater detail in Part II.

EXERCISE 14 (a). MENTAL.

Express as decimals of £1 correct to 3 places:

- | | | |
|--------------------------------|--------------------------------|--------------------------------|
| 1. 16s. 6d. | 2. 14s. 6d. | 3. 18s. $10\frac{1}{2}$ d. |
| 4. 13s. $10\frac{3}{4}$ d. | 5. 16s. $7\frac{1}{2}$ d. | 6. 12s. $8\frac{1}{2}$ d. |
| 7. 5s. $7\frac{1}{4}$ d. | 8. 13s. $7\frac{3}{4}$ d. | 9. £3. 17s. $9\frac{1}{2}$ d. |
| 10. £15. 8s. $7\frac{1}{2}$ d. | 11. £5. 12s. $9\frac{1}{2}$ d. | 12. £1. 11s. $1\frac{1}{4}$ d. |

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Bring the following to shillings and pence to the nearest penny:

- | | | |
|------------|------------|------------|
| 13. £·893. | 14. £·539. | 15. £·671. |
| 16. £·576. | 17. £·867. | 18. £·729. |
| 19. £·392. | 20. £·737. | 21. £·863. |

In each of the following examples bring the first quantity to the fraction of the second and then reduce to lowest terms, giving the two stages:

- | | |
|---|----------------------------------|
| 22. 1 ft. 9 in.; 3 ft. 1 in. | 23. 2 gall. 1 pt.; 9 gall. 1 pt. |
| 24. 2s. $4\frac{1}{2}d.$; 4s. $4\frac{1}{2}d.$ | 25. 3 tons 3 cwt.; 5 tons 5 cwt. |
| 26. 3 ft. 3 in.; 3 yd. 3 in. | 27. £5. 12s. 6d.; £10. 7s. 6d. |
| 28. 4 lb. 6 oz.; 5 lb. | 29. 3 cwt. 1 st.; 4 cwt. 3 st. |

In each of the following examples bring the first quantity to the decimal of the second, correct to two places; two stages may be shown if necessary:

- | | |
|-------------------------------|------------------------------|
| 30. 3s. 2d.; 4s. 2d. | 31. £1. 7s. 6d.; £3. 2s. 6d. |
| 32. 57 metres; 2 Hectometres. | 33. 42 lb.; 1 cwt. |
| 34. 5 cwt. 3 qr.; 1 ton. | 35. 24 min.; 2 hr. |
| 36. 2s. 9d.; 4s. 7d. | 37. 2 ft. 6 in.; 2 yd. |
| 38. 3 lb. 8 oz.; 5 lb. | 39. 1 gall. 1 pt.; 5 gall. |
| 40. 3 cwt.; 40 st. | |

EXERCISE 14 (b).

Find the value in £ s. d. of the following:

- | | |
|--------------|---------------|
| 1. £3·65625. | 2. £5·70125. |
| 3. £4·99875. | 4. £10·10375. |

Express as decimals of £1 correct to 5 places:

- | | |
|--------------------------------|-------------------------------|
| 5. £1. 17s. $5\frac{3}{4}d.$ | 6. £4. 12s. $10\frac{1}{2}d.$ |
| 7. £49. 13s. $11\frac{1}{2}d.$ | 8. £3. 17s. $1\frac{1}{4}d.$ |
| 9. £4 5s. $0\frac{1}{4}d.$ | 10. £10. 3s. $1\frac{1}{2}d.$ |

Reduce the following by stages, so as to give an answer correct to the nearest unit as far as is indicated in each

- | | |
|------------------------|------------------------|
| 11. ·7275 ton (stone). | 12. ·8375 yd. (in.). |
| 13. ·6875 mile (yd.). | 14. ·5225 gall. (pt.). |
| 15. ·2197 mile (yd.). | 16. ·00375 cwt. (oz.). |

Express the first of each of the following pairs as the fraction of the second in lowest terms, and then bring each to a decimal correct to 3 places:

17. 3 yd. 2 ft. 7 in.; 10 yd. 1 ft. 6 in.
18. 3 ml. 7 fur. 5 ch.; 5 ml. 5 fur. 3 ch.
19. 1 cwt. 1 qr. 12 lb.; $\frac{1}{2}$ ton.
20. 3 qt. 1 pt.; 1 gall. 2 qt. 1 pt.
21. £1. 5s. 6d.; £3. 11s. 6d.
22. £5. 14s. 5½d.; £10. 12s. 9½d.

Simplify:

23. $\frac{2}{3}$ of $\frac{1}{11}$ of 1 mile as a fraction of 960 feet.
24. $\frac{3}{8}$ of a mile + $\frac{17}{21}$ of 3 furlongs + $\frac{8}{77}$ of a pole in yards to the nearest yard.
25. $\frac{3}{4}$ of a crown + $\frac{5}{8}$ of a florin + $\frac{23}{4}$ of a crown + $\frac{37}{8}$ of a shilling + 7½ sixpences.
26. 5¼ of £16. 10s. 10¾d.
27. 7½ of £8. 9s. 10½d.
28. 3¼ of £8. 10s. 7½d.
29. 5⅞ of £5. 12s. 6¼d.
30. 6·12 of £6. 5s. 3½d. to the nearest penny.

EXERCISE 14 (c).

1. Given that 1 kilogram = 2·2 lb., reduce 593 grams to ounces to the nearest ounce.

2. A cistern full of water lost ·04 of its contents by leakage and then 368 gallons were drawn off, leaving the cistern half full. How many gallons were left in the cistern?

3. A man, having £11. 14s. 9½d. in his pocket, gave ·4 of it for 1·75 cwt. of beef. What was the price of the beef per lb.?

4. An estate is worth £25,000. A man who owns $\frac{8}{12}$ of it sells $\frac{3}{10}$ of his share. What is the value of the remainder?

5. Taking £1 to be equal to 4·87 dollars, find in English money the value of 194 dollars 80 cents.

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6. Find the value of $\frac{10}{11}$ of £1. 17s. 7d. — £1·0125.
7. How far does a train go in 5 min. 12 sec. if it is travelling at 45 miles an hour?
8. If 1 kilogram is taken as 2·205 lb., how many kilograms to the nearest unit are there in 1 ton 13 cwt. 23 lb.?
9. If 1 metre = 39·37 inches, find, correct to the nearest unit, the number of metres in 114 yd. 2 ft. 7 in.
10. At the time when £1 was worth 25·17 francs, how many francs had a merchant to pay in Paris for a banker's draft for £893. 15s.? Give the answer to the nearest franc.
11. Given that 1 metre = 39·37 inches, find the height in inches of a barometer which stands at 773 mm.
12. Find the height in mm. of another barometer which stands at 29·73 inches.
13. When the rate of exchange was £1 = 159·35 francs, what was the value of £7. 13s. 4d. in French money to the nearest hundredth of a franc?
14. After being used for a year, the value of machinery is reckoned at $\frac{9}{10}$ of its value at the beginning of that year. Some machinery cost £12,465 when new; at what price will it be valued at the end of 4 years? Answer to the nearest £.
15. A train does, on an average, every mile in $67\frac{1}{5}$ seconds. Find the speed in miles per hour, to the nearest tenth of a mile.
16. A shelf 50 cm. long is exactly filled by a number of books each 1·6 cm. thick and one thinner book. Find the thickness of this last book.
17. From 20 yd. of wire, how many pieces, each $7\frac{1}{8}$ inches long, can be cut, and what is the length of the piece left over?
18. What will be the general district rate (in shillings and pence) if £67,628 has to be collected in a district with a rateable value £804,345 and what would be the surplus if all the rates were collected?

BUSINESS CALCULATIONS, ETC.

42. The following *Aliquot* parts of £1, i.e. fractional parts having 1 for the numerator, need to be memorised:

£ $\frac{1}{2}$ = 10s.; £ $\frac{1}{3}$ = 6s. 8d.; £ $\frac{1}{4}$ = 5s.; £ $\frac{1}{5}$ = 4s.; £ $\frac{1}{6}$ = 3s. 4d.;
 £ $\frac{1}{8}$ = 2s. 6d.; £ $\frac{1}{10}$ = 2s.; £ $\frac{1}{12}$ = 1s. 8d.; £ $\frac{1}{15}$ = 1s. 4d.; £ $\frac{1}{16}$ = 1s. 3d.;
 £ $\frac{1}{20}$ = 1s.; £ $\frac{1}{24}$ = 10d.; £ $\frac{1}{40}$ = 6d.; £ $\frac{1}{60}$ = 4d.; £ $\frac{1}{80}$ = 3d.

Learn also the following:

£ $\frac{2}{3}$ = 13s. 4d.; £ $\frac{3}{4}$ = 15s.; £ $\frac{5}{6}$ = 16s. 8d.; £ $\frac{7}{8}$ = 7s. 6d.;
 £ $\frac{9}{10}$ = 12s. 6d.; £ $\frac{7}{8}$ = 17s. 6d.

43. Simple Practice.

It is possible to find the cost of a number of articles by adding together a succession of *aliquot parts*:

e.g. the cost at £1. 17s. 11½d.

= the cost at £1 + 10s. + 5s. + 2s. 6d. + 5d. + ½d.,

for 10s. = ½ of £1; 5s. = ½ of 10s.; 2s. 6d. = ½ of 5s.; 5d. = ½ of 2s. 6d.; ½d. = ½ of 5d.

The sum is set out as follows:

Find the cost of 357 articles at £1. 17s. 11½d. each.

| | £ | s. | d. | | £ | s. | d. |
|---------------------|------|-----|----|---------|----|----|-----|
| | 357 | 0 | 0 | cost at | 1 | 0 | 0 |
| 10s. 0d. = ½ of £1 | 178 | 10 | 0 | „ | 10 | 0 | „ |
| 5s. 0d. = ½ of 10s. | 89 | 5 | 0 | „ | 5 | 0 | „ |
| 2s. 6d. = ½ of 5s. | 44 | 12 | 6 | „ | 2 | 6 | „ |
| 5d. = ½ of 2s. 6d. | 7 | 8 | 9 | „ | | 5 | „ |
| ½d. = ½ of 5d. | 14 | 10½ | | „ | | ½ | „ |
| | £677 | 11 | 1½ | „ | £1 | 17 | 11½ |

Note that:

1. The cost at 17s. 11½d. would be found as above, except that a line would be drawn under £357 and this would be omitted from the addition.

2. Occasionally other than aliquot parts are used; but this may involve marginal working.

3. The cost of $357\frac{3}{4}$ articles would be found by taking £257. 15s. as the cost of one.

4. A better method in the above example would be to subtract the cost at $\frac{1}{2}d.$ from the cost at £1. 18s.

44. Compound Practice.

Find the cost of 5 tons 14 cwt. 3 qr. 21 lb. at £25. 17s. 6d. a ton.

(a) *Method 1.*

| | £ | s. | d. | |
|-------------------------------------|-------|----|-----------------|---|
| | 25 | 17 | 6 | |
| | | | 5 | |
| | <hr/> | | | |
| | 129 | 7 | 6 | |
| 10 cwt. = $\frac{1}{2}$ of 1 ton | 12 | 18 | 9 | |
| 2 cwt. = $\frac{1}{5}$ of 10 cwt. } | 2 | 11 | 9 | |
| 2 cwt. = $\frac{1}{5}$ of 10 cwt. } | 2 | 11 | 9 | |
| 2 qr. = $\frac{1}{4}$ of 2 cwt. | 12 | 11 | $\frac{1}{4}$ | $\frac{1}{4} + \frac{5}{8} + \frac{13}{16} + \frac{13}{32}$ |
| 1 qr. = $\frac{1}{2}$ of 2 qr. | 6 | 5 | $\frac{5}{8}$ | $= \frac{8 + 20 + 26 + 13}{32}$ |
| 14 lb. = $\frac{1}{2}$ of 1 qr. | 3 | 2 | $\frac{13}{16}$ | $= \frac{67}{32} = 2\frac{3}{32}$ |
| 7 lb. = $\frac{1}{2}$ of 14 lb. | 1 | 7 | $\frac{13}{32}$ | |
| | <hr/> | | | |
| | £148 | 14 | $0\frac{3}{32}$ | Ans. |

(b) *Method 2.*

| | £ |
|----------------------------------|-----------|
| | 25·875 |
| | 5 |
| | <hr/> |
| | 129·375 |
| 10 cwt. = $\frac{1}{2}$ of 1 ton | 12·9375 |
| 4 cwt. = $\frac{1}{5}$ of 1 ton | 5·175 |
| 2 qr. = $\frac{1}{8}$ of 4 cwt. | ·64687 |
| 1 qr. = $\frac{1}{2}$ of 2 qr. | ·32343 |
| 14 lb. = $\frac{1}{2}$ of 1 qr. | ·16171 |
| 7 lb. = $\frac{1}{2}$ of 14 lb. | ·08085 |
| | <hr/> |
| | 148·70036 |

£148. 14s. to the nearest penny.

EXERCISE 15 (a). MENTAL.

Give the following fractions of £1 in shillings and pence:

- | | | | |
|-----------------------|--------------------|--------------------|-----------------------|
| 1. (a) $\frac{1}{8}$ | (b) $\frac{3}{8}$ | (c) $\frac{5}{8}$ | (d) $\frac{7}{8}$. |
| 2. (a) $\frac{1}{5}$ | (b) $\frac{2}{5}$ | (c) $\frac{3}{5}$ | (d) $\frac{4}{5}$. |
| 3. (a) $\frac{1}{12}$ | (b) $\frac{5}{12}$ | (c) $\frac{7}{12}$ | (d) $\frac{11}{12}$. |
| 4. (a) $\frac{1}{15}$ | (b) $\frac{4}{15}$ | (c) $\frac{7}{15}$ | (d) $\frac{14}{15}$. |
| 5. (a) $\frac{1}{16}$ | (b) $\frac{7}{16}$ | (c) $\frac{3}{16}$ | (d) $\frac{11}{16}$. |

What parts of £1 are the following?

- | | | |
|-------------|-------------|------------|
| 6. 13s. 4d. | 7. 16s. 8d. | 8. 3s. 9d. |
| 9. 12s. 6d. | 10. 5s. 4d. | |

Find the costs of:

11. $4\frac{1}{4}$ lb. of butter at 2s. 4d. a lb.
12. 29 books at £4. 10s. for 30.
13. 125 oranges at 1s. 6d. a dozen.
14. 7 ties at 42s. a dozen.
15. 2 dozen fountain pens at 17s. 6d. each.
16. 600 articles at $2\frac{1}{2}$ d. a dozen.
17. 30 eggs at 4 for 1s. 6d.
18. $\frac{1}{2}$ cwt. of tea at 2s. 0d. a lb.
19. 12 gall. at $2\frac{1}{2}$ d. a pt.
20. 1 gross of collars at 2s. 9d. a half-dozen.
21. 24 lb. of cheese at $11\frac{1}{2}$ d. a lb.
22. 4 dozen articles at $7\frac{3}{4}$ d. each.
23. 56 articles at 17s. 6d. each.
24. 56 chairs at 19s. 11d. each.
25. 6 cwt. 28 lb. of coal at £4 a ton.
26. 35 articles at 5s. 6d. a dozen.
27. 2 qr. 8 lb. at 28s. per qr.
28. 1 ton at 6d. a lb.
29. $2\frac{1}{2}$ gross of buttons at $1\frac{1}{2}$ d. each.
30. 3 dozen locks at 7s. 6d. each.

31. 720 articles at 7s. 4d. each.
32. 640 articles at 7s. 6d. each.
33. 32 at 4s. 11d. each.
34. 64 at 2s. 7½d. each.
35. 10,000 pins at 50 for a penny.
36. 3 tons 15 cwt. at 28s. a ton.

EXERCISE 15 (b).

Find the costs of the following articles:

1. 256 at £3. 18s. 9d. each.
2. 3795 at 1s. 4½d. each.
3. 319 at 17s. 11½d. each.
4. 5354¾ cwt. of soap at £4. 4s. 8d. per cwt.
5. 2895 at £3. 19s. 11½d. each.
6. 28,973 at 13s. 10½d. each.
7. 4329 at 15s. 6¼d. each.
8. 123½ dozen at 1s. 7½d. each.
9. 135 trucks of ore, each containing 14 tons, at £3. 15s. 6d. per ton.
10. 5½ gross at £1. 13s. 9d. each.

Find the costs of:

11. 12 qr. 3 bush. 3 pk. at £2. 2s. 8d. per quarter.
12. 190 acres 3 roods 34 poles at £84. 6s. 8d. per acre.
13. 29 acres 2 roods 35 poles at 8s. 0d. per acre for mowing.
14. 237 tons 15 cwt. 2 qr. at £1. 9s. 2d. per ton.
15. 5 acres 2 roods 24 poles at £57. 12s. 6d. per acre.
16. 36 tons 5 cwt. 16 lb. at £51. 6s. 8d. per ton.
17. 9 cwt. 70 lb. at £23. 6s. 8d. per ton.
18. 17 tons 3 cwt. 3 qr. at £15. 17s. 6d. per ton.
19. 5 miles 3 fur. 55 yd. of fencing at £70. 15s. per mile.
20. 2 miles 1014 yards of road at £783. 15s. per furlong.

EXERCISE 15 (c).

1. Find the total cost, reckoning each item to the nearest farthing, and neglecting farthings in the total:

- 12 $\frac{1}{4}$ yd. of satin at 15s. per yd.
- 7 yd. of calico at 1s. 1 $\frac{1}{2}$ d. per yd.
- $\frac{3}{4}$ yd. of muslin at 6 $\frac{1}{2}$ d. per yd.
- 7 yd. of braid at 8 $\frac{3}{4}$ d. per yd.
- 18 buttons at 9 $\frac{3}{4}$ d. a dozen.
- 24 inches of ribbon at 1s. 10 $\frac{3}{4}$ d. per yd.

2. Find the total cost of:

- 60 yd. material at 5d. per yd.
- 41 $\frac{1}{2}$ yd. ribbon at 7d. per yd.
- 62 $\frac{1}{2}$ yd. satin ribbon at 8 $\frac{1}{2}$ d. per yd.
- 49 $\frac{1}{4}$ yd. velvet at 6s. per yd.
- 1 needlework case at £2. 12s. 3d. per doz.

Deduct, as discount for cash, 6d. in each complete £.

3. Make out the following grocer's bill:

- 1 $\frac{3}{4}$ lb. bacon at 1s. 8d. per lb.
- 2 $\frac{1}{2}$ lb. rice at 4 $\frac{1}{2}$ d. per lb.
- 3 lb. gran. sugar at 3 $\frac{3}{4}$ d. per lb.
- 1 doz. lb. preserving sugar at 5 $\frac{1}{4}$ d. per lb.
- $\frac{3}{4}$ lb. tea at 1s. 10d. per lb.

4. Find the total cost of:

- 2 $\frac{1}{2}$ lb. loin of lamb at 1s. 8d. per lb.
- 1 lb. 9 oz. steak at 1s. 4d. per lb.
- $\frac{1}{2}$ lb. kidney at 1s. 3d. per lb.
- 4 lb. 5 oz. leg of pork at 1s. 4d. per lb.
- 1 turkey weighing 19 lb. at 1s. 3d. per lb.

5 Complete the invoice given below:

- 37 yd. calico at 1s. 4d. per yd.
- 19 yd. flannel at 2s. 11 $\frac{1}{2}$ d. per yd.
- 22 yd. silk at 4s. 7d. per yd.
- 18 yd. linen at 3s. 5d. per yd.
- 17 yd. ribbon at 1s. 9d. per yd.
- 11 pr. gloves at 4s. 9d. per pair.

Deduct 1s. in the £ as discount for cash.

6. An account is received from your butcher as follows:

HIGH STREET, POPLAR.
3 March, 1928.

Mrs J. RUDDOCK.

Bought of W. JELKS & Co.
Family Butchers.

| | | | lb. | oz. | per lb. | £ | s. | d. |
|------|----|-------------------|-----|-----|---------|---|----|----|
| Dec. | 27 | Sirloin | 4 | 5 | 1/4 | | 5 | 10 |
| „ | 30 | Mutton Chops ... | 2 | 2 | 1/5 | | 3 | 0½ |
| Jan. | 2 | Leg of Mutton ... | 6 | 4 | 1/2 | | 7 | 4 |
| | | | | | | | 16 | 2½ |

Work out the items, and give the correct amounts.

7. Make out the following bill and find the total:

5 doz. 12-in. rulers at 3¼*d.* each.

2½ doz. set-squares at 10½*d.* each.

2¼ doz. protractors at 5*s.* 6*d.* per doz.

27 compasses at 7*s.* 9*d.* per doz.

2 doz. drawing boards at 2*s.* 4½*d.* each.

8 doz. pencils at 8*s.* 3*d.* per gross.

8. Find the total cost of:

212 yd. gaberdine at 9*s.* 6*d.* per yd.

156 yd. velvet at 5*s.* 10*d.* per yd.

318 yd. lace at 1*s.* 11½*d.* per yd.

Allow 2*s.* in the £ discount for cash.

9. Make out the following bill:

15 doz. quires foolscap at 7*s.* 3*d.* per ream (20 quires).

2750 small envelopes at 11*s.* 6*d.* per 1000.

2½ gross thick Manilla envelopes at 7*s.* 6*d.* per 100.

1000 sheets blotting paper at 2*s.* 9*d.* per quire
(24 sheets).

500 cash note books at 12*s.* 6*d.* per gross.

10. Make out an invoice for the following:

9 pairs of blankets at 23s. 6d. per pair.

56 yards of calico at 1s. 0 $\frac{3}{4}$ d. per yd.

35 yards of tweed at 11s. 6d. per yd.

2 $\frac{1}{2}$ doz. pairs of gloves at 15s. 11d. per pair.

3 $\frac{3}{4}$ doz. pairs of socks at 3s. 10 $\frac{1}{2}$ d. per pair.

11. If a bankrupt's debts amount to £3837. 9s. 6d. and he is able to pay only 5s. 9d. in the £, what are his assets to the nearest penny?

12. When gas cost 2s. 4d. per 1000 cub. ft., the amount consumed in a house during three months cost £2. 12s. 6d. How much would it have cost if the price had been 2s. 10d. per 1000 cub. ft.?

13. If 3 lb. of tea costing 2s. 4d. per lb., 5 lb. costing 2s. 2d. per lb., and 2 lb. costing 2s. per lb. are mixed together, what is the value, to the nearest penny, of a pound of the mixture?

14. *B* sells to *C* 48 lb. of apples at 7d. a lb., and takes in exchange oranges at 1s. 4d. per doz. How many dozen oranges will *B* have to receive?

15. 200 tons of coal were purchased at the rate of £2 a ton. 150 tons were sold at a profit representing $\frac{1}{5}$ of the cost price per ton and the remainder at a loss of $\frac{1}{8}$. What was the amount of the actual profit?

16. The total rateable value of a town is £268,764. How much money can be raised by a rate of 1s. 4d. in the £?

17. Make out the following invoice: 25 golf bags at 3s. 11 $\frac{1}{2}$ d. each; 240 golf balls at 19s. 6d. per dozen; 75 golf clubs at 4s. 8d. each; 150 golf shafts at 15s. 9d. per score.

18. A grocer sold 21 lb. of tea at 2s. 3d. per lb.; 25 lb. at 1s. 9d. per lb.; 9 lb. at 3s. 6 $\frac{1}{2}$ d. per lb.; 12 lb. at 3s. 3d. per lb. Find to the nearest penny the average price per lb.

19. Make out the following invoice and deduct 1s. 6d. in the £ (from complete £'s only) for cash payment: 3 turkeys, weighing respectively 11 $\frac{3}{4}$ lb., 14 $\frac{1}{2}$ lb., and 16 $\frac{1}{4}$ lb., at 1s. 3d. per lb.; 19 lb. of beef at 11 $\frac{1}{2}$ d. per lb.; 9 rabbits at 1s. 3 $\frac{1}{4}$ d. each; $\frac{1}{4}$ cwt. of potatoes at 3 lb. for 2 $\frac{1}{4}$ d.

20. The price of 20 tons of coal at the pit mouth was £25. 8s. 4d. It was carried 40 miles by rail at a cost of $\frac{3}{8}$ d. per ton per mile, and was then retailed at a profit of 5s. 10d. per ton. What was the price per ton retail?

21. A merchant sold $\frac{1}{4}$ of a stock of gloves at a profit of 9d. a pair, $\frac{1}{8}$ at a profit of 6d. a pair, and the remainder at a loss of 4d. a pair. What was the average profit or loss on each pair sold?

22. A master employs 24 workmen and their wages for 50 weeks averaged 10s. 8d. per hour per man. If each man worked an average of 49 hours per week, find the total wages bill for the whole time.

23. The average weight of 24 blocks of stone is 1 cwt. 20 lb. Another block is added and the average weight of the lot is then 133 lb. What is the weight of the added block?

24. A bookseller bought 228 books at an average price of 8½d. each. For 80 he gave 6d. each, for 48 he gave 7½d. each, and for 84 he gave 10½d. each. What was the average price of the remainder?

MISCELLANEOUS FRACTIONS AND DECIMALS

EXERCISE 16 (a). MENTAL.

1. How many hundredths are there in 39·2?
2. $\frac{2}{3} + \frac{1}{4} - \frac{1}{2}$. 3. $\frac{5}{6} - \frac{4}{9}$.
4. How often is $1\frac{1}{2}$ contained in $13\frac{3}{4}$?
5. Express £3·5 × ·6 in £ s. d.
6. Express 17s. 8d. as a decimal of £1 correct to 3 places.
7. How many thousands are there in 95625?
8. 264×125 . 9. $0\cdot5672 \div 0\cdot008$.
10. $2\frac{1}{6} + 1\frac{2}{3} - \frac{1}{2}$. 11. 0·68 of 250.
12. What is the value of 2·45 of £6 in £ s. d.?
13. $£125 \times 4\frac{3}{5}$. 14. $2398 \div 25$.
15. Express $\frac{5}{8}$ and $\frac{3}{80}$ as decimals.
16. Bring 3 lb. 2 oz. to the fraction of 8 lb. 2 oz. in lowest terms.
17. Reduce to lowest terms $\frac{19}{152}$, $\frac{13}{117}$, $\frac{17}{119}$.
18. Multiply ten thousand by 1·001.
19. $288 \times 2\frac{1}{12}$. 20. $6900\cdot69 \div 2\cdot3$.
21. Express $\frac{1}{10}$ as a decimal.
22. $1\cdot7 + 2\cdot34 + 4\cdot036 + 20 + 7\cdot138 + 19\cdot27$.
23. Bring £5·775 to £ s. d.
24. $\frac{2}{3}(\frac{3}{4} + \frac{9}{10})$. 25. $2 - (\frac{4}{5} + \frac{9}{10})$.
26. What fraction is 15·6 of 39?
27. $0\cdot8 \times 0\cdot9 \div \cdot12$. 28. $36\cdot42 \times 0\cdot25$.
29. 1s. 4d. × 3600. 30. 4 tons 17 cwt. at £2. 10s. per ton.

EXERCISE 16 (b).

1. $389\cdot464 \div \cdot356$. 2. $56\cdot12 \times \cdot375$.
3. Find the cost, to the nearest penny, of 478 gallons at 4·16 shillings per gallon.
4. $\frac{\frac{1}{3} \div (1\frac{1}{3} + \frac{1}{3})}{\frac{7}{10} + \frac{2}{3} + \frac{1}{2}}$. 5. $\frac{\frac{1}{7} \times (\frac{1}{8} + \frac{1}{4})}{\frac{1}{9} \times (\frac{2}{7} - \frac{1}{4})}$.

6. $(\frac{3}{4} + \frac{1}{2} \text{ of } \frac{3}{8}) \div (\frac{1}{2} + \frac{3}{4} \text{ of } \frac{3}{8})$. 7. $\frac{.75 \times .75}{.75 - .05} - \frac{.05 \times .05}{.75 - .05}$.
8. $\frac{1\frac{2}{3} \text{ of } 1\frac{1}{4}}{3\frac{2}{5} + (5 \div 1\frac{1}{4})}$. 9. $\frac{2\frac{3}{8} - 1\frac{17}{32}}{1\frac{4}{5} \text{ of } 1\frac{7}{8}}$.
10. $\frac{9\frac{1}{5} + 3 \times 1\frac{4}{5}}{14\frac{2}{3} - 3\frac{1}{4} \text{ of } 3\frac{8}{9}}$.
11. $\frac{2.05 \times .026}{3.573 - 3.55168}$ (correct to 3 places).
12. $\frac{\frac{3}{7} + \frac{5}{9}}{(2\frac{1}{3} - \frac{2}{7}) \times \frac{9}{17} - \frac{58}{119}}$. 13. $\frac{6\frac{2}{3} - 1\frac{1}{5}}{2\frac{1}{3} + 3\frac{3}{4} - 1\frac{2}{5}}$.
14. $\frac{15.036 - 7.8456}{.075}$ (correct to the nearest unit).
15. Find the value of £3.54875, to the nearest penny.
16. Find by Practice the cost of 2 tons 9 cwt. 3 qr. 15 lb. at 16s. 4d. per cwt.
17. Express £3. 8s. 9d. as a decimal of £5.
18. $\frac{4\frac{3}{4} + 1\frac{1}{2} - \frac{2}{7} \times 2\frac{3}{4}}{1\frac{1}{2} - \frac{5}{8} + 1\frac{5}{6} \div 1\frac{1}{18}}$.
19. $\frac{5}{12} + \frac{21}{2} \text{ of } \frac{4}{7} - \frac{4}{9} \times \frac{3}{11} \div \frac{1}{6}$. 20. $\frac{12.255 \times 0.032}{0.00048}$.

EXERCISE 16 (c).

1. A bankrupt whose debts amount to £1345 pays 8s. 10½d. in the £. Find the amount of his net assets to the nearest £.

2. Divide .03486 by 4.98. Then write down (without actually working) the answers to the following:

$$\frac{3.486}{498}; \quad \frac{3486}{4.98}; \quad \frac{34.86}{49.8}.$$

3. The rent of a house is £80. 10s. 0d. per annum and the rates are assessed on $\frac{1}{4}$ of that sum. If the rates consist of two half-yearly payments of 4s. 4d. in the £ on the amount assessed, find the total sum paid in rent and rates in one year.

4. The average temperature in a class room for a week of 5 days was 64°. On Monday the temperature was 61.5°, Tuesday 66.9°, Thursday 63.8°. Find the average temperature for Wednesday and Friday.

5. How much discount has been allowed if £10 is accepted in payment of the bill below?

10,000 envelopes at 1s. 9d. per 250;

$3\frac{3}{4}$ gross of pens at $6\frac{1}{2}d.$ per dozen;

250 quires of notepaper at 4s. 6d. per ream (20 quires);

36 boxes of colours at $8\frac{1}{2}d.$ each;

6 gallons of ink at 4s. $11\frac{3}{4}d.$ per gallon.

6. A bookseller sold $\frac{2}{3}$ of the copies of a certain book which he stocked, and $\frac{1}{6}$ of the remainder were destroyed by fire. He then had 1250 left. How many copies had he at first?

7. A man had two sons. To the elder he left $\frac{5}{11}$ of his estate, and the younger $\frac{2}{3}$ of the remainder, the rest going to his widow. If the widow's share was £4400, what was the value of the whole estate?

8. What is the fraction which is as much more than $\frac{1}{16}$ as it is less than $\frac{1}{15}$?

9. An indiarubber ball bounces $\cdot 585$ of the height from which it falls. If thrown to a height of 72 feet, find approximately how high it will rise on the second rebound.

10. A cistern is $\frac{5}{8}$ full. 14 gallons are withdrawn and it is then $\frac{3}{8}$ full. How many gallons does it hold?

11. What is the average cost per ton, to the nearest penny, of 400 tons of coal if 240 tons of it cost 18s. 6d. a ton and the remainder 19s. 6d. a ton?

12. Taking the circumference of a circle as 3·14 times its diameter, find how many times a bicycle wheel with a diameter of 28 inches turns while the bicycle goes a mile. Give your answer to the nearest whole number.

12. Taking 8 Kilometres as equal to 5 miles, reduce a speed of 57·2 Kilometres per hour to a speed in feet per second. Give the answer to one place of decimals.

14. The rateable value of property in a borough being £2,403,762, find what sum is produced by a rate of 17·67 pence in the £. Answer to the nearest £.

15. When £1 was worth 104·2 francs, find the value in francs of £17. 3s. 9d. Give the answer to the nearest franc.

16. A grocer sells $\frac{1}{5}$ of his stock of 1200 lb. of tea at 2s. $10\frac{1}{2}$ d. per lb., $\frac{1}{3}$ at 2s. $7\frac{1}{2}$ d. per lb., and the remainder at 2s. 3d. per lb. Find the average selling price per lb.

17. When the exchange was £1 = 56·25 francs, find the value in French money of £8. 16s.

18. A new locomotive, on a trial run, went part of the way at a speed of 81 miles an hour. Find, to the nearest tenth of a second, how long it would take, at that speed, to do $1\frac{3}{4}$ miles.

19. Find the value of 1,217,400 lb. of tea at an average price of 2s. $3\frac{1}{4}$ d. per lb.

20. A tradesman sold an article at a price one-fourth greater than the price at which he bought it. If he sold at 3s. 4d. per lb., how much did it cost him per cwt.?

SECTIONAL REVISION B

EXERCISE 17 (a). MENTAL.

1. £156. 15s. 9d. + £3164. 12s. 10½d. + £1583. 12s. 11d.
2. £3589. 15s. 3d. ÷ 11.
3. 3 tons 15 cwt. 2 qr. × 8.
4. Express 2 m. 3 dm. 4 cm. × 1000 in Km.
5. 13,563 × 25.
6. 17,625 ÷ 125.
7. $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$.
8. $3\frac{1}{4} \div 4\frac{1}{3}$.
9. 7·204 ÷ ·8.
10. $2 \times 3 \times 4 \times 5 \times 6 \times 7$.
11. How many thousandths are there in ·7?
12. Bring £13. 9s. 6d. to sixpences.
13. What is the cost of 25,000 articles at 4s. per 100?
14. Express 22 yd. as a fraction of a mile, in lowest terms.
15. How many 2s. 3d. ties can be bought for £2. 5s.?
16. Express £·925 in shillings and pence.
17. Find the cost of $4\frac{1}{2}$ yd. of ribbon at $\frac{1}{2}$ d. an inch.
18. $\frac{2}{3}(1 - \frac{2}{3})$.
19. Express $4\frac{8}{9}$ as a decimal.
20. Find the cost of 18 hats at £1. 7s. 6d. a dozen.

EXERCISE 17 (b).

1. $(2\frac{2}{3} + 3\frac{3}{4}) \div (4\frac{1}{4} - \frac{1}{6})$.
2. Find the cost of 16 acres 3 roods 33 poles at £2. 12s. an acre.
3. Take $\frac{4}{15}$ of 11s. 3d. from $\frac{7}{12}$ of 10s. 6d.
4. Multiply 3·9625 by ·864.
5. Find the H.C.F. of 912 and 756.
6. Find the value correct to 3 places of decimals of $\frac{8}{73} - \frac{15}{236}$.
7. Divide 5 tons 18 cwt. 3 qr. 7 oz. by 301.
8. What are the prime factors of 102,102?
9. Simplify $33\cdot21 \div \cdot0205 - \frac{4}{5}$ of 51·25.
10. Find to the nearest penny the value of $3\frac{7}{8}$ of £23. 17s. 9d. + $7\frac{3}{11}$ of £17. 0s. 10d.

EXERCISE 17 (c).

1. If 1 gallon = 4·54 litres, find to the nearest litre the number of litres in $56\frac{1}{2}$ gallons.

2. Decimalise the following amounts correct to 5 places, and hence find the total in £ s. d.: £564. 17s. 9d.; £253. 12s. 3d.; £491. 17s. $11\frac{1}{2}$ d.

3. A cask contains 20 gallons. I withdraw ·04 of it, then ·04 of the remainder, and finally ·04 of the second remainder. How much is left?

4. If the sum of £214. 9s. 3d. is divided among 53 women and 27 children so that each woman receives twice as much as each child, how much does each woman receive?

5. What profit is made by buying 10 gross of articles for £25. 10s. 6d., and selling 500 of them at 6d. each and the rest at $6\frac{1}{2}$ d. each?

6. When cigarettes cost 4s. a hundred a man smoked 15 a day, but when the cost rose by 8d. a hundred he reduced his consumption to 10 a day. How much did he save in a year?

7. Find the total cost of $\frac{3}{4}$ ream notepaper at 3s. 3d. per ream; 2500 envelopes at 2s. 11d. per 100; 100 cards at 1s. 3d. per dozen; $2\frac{1}{2}$ dozen pencils at 11s. 0d. per gross.

8. A litre of water weighs a kilogram. Glycerine is 1·26 times as heavy as water. What is the weight in kilograms of 7·65 litres of glycerine?

9. A bankrupt possessed £5580, one-eighth of which went in legal expenses, and he paid his creditors 7s. 9d. in the £. What was the total amount of his debts?

10. A sum of £35 is paid in wages to 8 bricklayers and 8 labourers. If the pay of 4 labourers is the same as that of 3 bricklayers, how much will each bricklayer receive?

1

17. Find the value of $\cdot 375$ of £6.
18. What are the total wages for 52 weeks at £2. 5s. per week?
19. Find the cost of 17 chairs at 19s. 11d. each.
20. What is the L.C.M. of 10, 15, 20?

1. Find the L.C.M. of 143, 156, 132.

2. Reduce 4 feet to the fraction of $\frac{7}{11}$ of a pole.
3. Simplify $2\frac{1}{3}$ of $1\frac{4}{8} - 2\frac{1}{3}$ of $\frac{2}{5}$.
4. Bring 17s. $0\frac{3}{4}d.$ to the decimal of £2.
5. What fraction of £29. 6s. $0\frac{1}{2}d.$ is £17. 11s. $7\frac{1}{2}d.$? Reduce the fraction to lowest terms.
6. Divide .0071 by .6937, giving the answer correct to 4 places of decimals.
7. Simplify $\frac{3}{44}$ of a mile + $\frac{17}{55}$ of a furlong + $\frac{3}{4}$ of 2 chains.
8. Find the value of .65625 of a ton in cwt. and lb.
9. Simplify $\frac{7}{5}$ of £11. 15s. 6d – £9.05625.
10. Find the continued product of .75 × 1.25 × 36.

EXERCISE 18 (c).

1. Decrease £2375 by $\cdot 14$ of that amount, and the result by $\cdot 14$ of that result.

2. Oranges are purchased at 16 for 1s. What must be their selling price in order to make a profit of 4d. in every shilling?

3. Find the total amount of the following bill, and then deduct 2s. in the £ discount for cash:

1½ cwt. of sugar at 1¾d. per lb.;

2¼ cwt. of salt at 4 lb. for 1½d.;

9 boxes of oranges, each containing 8 dozen, at ¾d. each;

10 cheeses, each weighing 24½ lb., at 8½d. per lb.

4. At the time when War Savings Certificates could be purchased at the rate of £77. 10s. per 100, what was the cost of 350 such certificates?

5. A cyclist finds that each pedal goes round 275 times while he rides a mile. How far does he ride while doing 1000 turns with each pedal?

6. What is the largest exact number of dollars worth 4s. 1½d. which can be obtained for £400?

7. Express 4 gallons 3 quarts 1½ pints in gallons and a decimal of a gallon.

8. A candidate was defeated by a majority of 1729 votes out of 10,731 recorded. How many votes were recorded for and against him?

9. Travelling by bicycle at an average rate of 10½ miles an hour, a person reaches a certain place in 8½ hours. How long will the same journey take by a motor cycle travelling at an average rate of 25½ miles an hour?

10. What is the value of 9 bags, each containing 6 cwt. 3 qr. 12 lb. of rice at £1. 17s. 4d. per cwt.?

EXERCISE 19 (a). MENTAL.

1. $29,876 + 398 + 1564 + 83,108$.
2. $£35. 17s. 6\frac{1}{2}d. \times 11$. 3. 3 tons 15 cwt. 2 qr. $\div 8$.
4. Find the difference between $3\frac{1}{2}$ yd. and 2 yd. 1 ft. 3 in.
5. How many half-crowns are there in $£25. 7s. 6d.$?
6. What is the cost of 4 dozen articles at $5\frac{3}{4}d.$ each?
7. Express 36 minutes as a fraction of $1\frac{1}{2}$ hrs. in lowest terms.
8. If 5 ounces cost $7\frac{1}{2}d.$, what is the price per lb.?
9. Bring $13s. 6d.$ to the decimal of £1.
10. $\frac{3}{4} + \frac{1}{6} + \frac{1}{2}$. 11. $2\frac{2}{3} \div 1\frac{1}{7}$.
12. $35.2 \div .8$. 13. $15.642 \times .5$.
14. What are the wages for 56 hours at $1s. 3d.$ per hour?
15. Find the discount on $£3. 15s.$ at the rate of $6d.$ in the £.
16. Find the H.C.F. of 45, 60, 90.
17. $9125 \div 125$. 18. 347×25 .
19. What is the cost of 9 dozen articles at $1s. 1d.$ each?
20. 3 yd. 1 ft. 6 in. at $2s.$ per yd.

EXERCISE 19 (b).

1. Reduce 1 ton 4 cwt. 97 lb. to lbs.
2. Divide the sum of 822,999 and 307,694 by 33.
3. $£7. 13s. 3d. \times 6\frac{7}{12}$.
4. Find the H.C.F. of 2652 and 19,625.
5. Find by Practice the cost of 16 cwt. 3 qr. $15\frac{1}{2}$ lb. at 40 guineas per ton.
6. Simplify $4\frac{5}{8} - (3\frac{3}{4} \div 1\frac{1}{8})$. 7. Simplify $\frac{3.26 \times 1.78}{8.15 \times .89}$.
8. Express 2 qr. 15 lb. as the decimal of a hundredweight correct to 3 places of decimals.
9. Bring .010925 of a mile to yards, feet and inches to the nearest inch.
10. Simplify $(3.52 \div .05) \times (1.02 \div 5.1)$.

EXERCISE 19 (c).

1. What sum must be subtracted from three million four hundred and fifty-six thousand and one, to make it exactly divisible by five hundred and nine?

2. In 1927 a man received a salary of £36. 13s. 4d. per calendar month. During the year he saved £35. What was his average daily expenditure to the nearest penny?

3. In weighing coal to fill 152 sacks with a cwt. each, two 56 lb. weights were used. One weight was found to be $7\frac{1}{4}$ oz. too light, and the other $2\frac{3}{4}$ oz. too heavy. Find the real weight of all the coal in tons, cwt., etc.

4. If 25 tons 15 cwt. of coal, costing 35s. per ton, are sold at 2s. 3d. per cwt., what is the total gain?

5. If 7523 persons are to contribute equally to pay £10,000, find to the nearest penny the share of each. If this sum is paid by each, how much remains to be paid?

6. If a man bought 1500 eggs for £5. 10s. 6d., what profit would he obtain by selling them at 2s. 3d. per dozen?

7. Find the difference in pence between $\frac{17}{8}$ of £5 and £0.7625.

8. Find the total cost of:

18½ yd. silk at 5s. 6d. per yd.;

64 yd. sheeting at 1s. 4½d. per yd.;

4 pairs of blankets at 18s. 4d. per pair;

3 pairs of sheets at 12s. 8d. per pair;

26 yd. alpaca at 10¾d. per yd.;

2 gross safety pins at 3d. per dozen.

9. How many times can 2.8 cm. be measured from 2 metres, and what length remains?

10. A certain firm employs 2020 hands—men, women and boys. The men and women together number 1548; the women and boys together number 1012. How many men, women and boys are there respectively?

EXERCISE 20 (a). MENTAL.

1. $83,529 + 14,786 + 2954 + 37,825 + 15,630$.
2. £256. 17s. $3\frac{1}{2}d.$ - £187. 19s. $5d.$
3. 2 lb. 13 oz. + 5 lb. 5 oz. + 8 lb. 15 oz. + 1 lb. 15 oz.
4. Find the cost of $2\frac{7}{8}$ yd. of material at 16s. a yard.
5. Add $\frac{4}{7}$ of a guinea to $\frac{4}{5}$ of half a crown.
6. 55×99 . 7. $\cdot 625 \times 864$.
8. $3\cdot152 \div \cdot 8$. 9. $3\frac{1}{3} \div 2\frac{2}{3}$.
10. $2\frac{2}{5}$ of $\frac{3}{4}$. 11. Express £·95 in s. $d.$
12. Bring $\frac{1}{32}$ to a decimal.
13. How many half-pounds are there in a quarter of a cwt.?
14. Find the average of 10, 12, 14, 16.
15. What is the L.C.M. of 6, 8, 12, 15?
16. Find the cost of 240 articles at $6\frac{1}{2}d.$ each.
17. $\frac{1}{3} + \frac{1}{4} - \frac{1}{12}$.
18. What is the cost of 19 lb. of beef at $11\frac{3}{4}d.$ per lb.?
19. Find the cost of 6 ounces at 2s. per lb.
20. What is the difference of the place values of the two figures in $\cdot 26$?

EXERCISE 20 (b).

1. Simplify $3\frac{3}{4} \times 4\frac{5}{8} \times 9\frac{3}{5}$.
2. Use a short method to multiply 5642 by 998.
3. Find the product of $\cdot 567$ and $35\cdot 8$.
4. Find the cost, to the nearest shilling, of 356 yards 2 feet $11\frac{1}{2}$ inches of material at the average price of 15s. $11\frac{3}{4}d.$ per yard.
5. What fraction is £1. 5s. of £1. 15s.? Give the answer also as a decimal correct to 3 places.
6. (a) $10\cdot 608 \times 40\cdot 545$.
(b) $106080 \times \cdot 0040545$.

7. What fraction of a ton is 13 cwt. 3 st. 11 lb.?
8. Find by the method of prime factors the H.C.F. of 832 and 1024.
9. Express the result of $\frac{7}{13} - \frac{2}{15}$ as a decimal correct to 3 places.
10. Find the value of 6.35 of £5. 17s. 6d.

EXERCISE 20 (c).

1. A manufacturer used 5 cwt. of tobacco in making up 8904 ounce packets. What percentage was wasted?

2. If a grocer buys oranges at the rate of 10d. a score, how many should he sell for 1s. in order to make a profit at the rate of 4s. in the £?

3. When the franc was worth $1\frac{3}{4}$ d., how many francs could be obtained for £1. 17s. 10d.? Give the result to the nearest whole number.

4. In a division sum the divisor is 235, the quotient 185, and the remainder 27. What is the dividend?

5. A traveller who used a certain railway line 5 days a week had a season ticket costing £4. 5s. 6d. a quarter. How much more would it cost in a year of 52 weeks if he paid the ordinary fare twice a week and a cheap return on the other three days, if the former cost 1s. 2d. a journey and the latter 1s. 2d. return?

6. A dealer buys two tons of meat at £97 per ton and sells three-quarters of it at £5. 10s. per cwt. At what price must he sell the remainder so as to make a profit of £20 on the transaction?

7. An express non-stop train leaves Paddington for Bristol, 117 miles distant, at 12.15 p.m. and arrives at Bristol at 2.30 p.m. Find the average time per mile to the nearest second.

8. A cubic foot (1728 cubic inches) of water weighs $62\frac{1}{2}$ lb. and 1 gallon weighs 10 lb. How many cubic inches are there in a pint?

9. If the rates in a certain district amount to 6s. 5d. in the £, what is due on a rental of £875. 10s., to the nearest penny?

10. A owns $\frac{4}{7}$ of a business and B the rest. The difference in the value of their shares is £35. What is the business worth?

RATIO AND PROPORTION

45. Ratio.

The relation between the magnitudes of two quantities of the same kind is sometimes called the *ratio* between them, the comparison being made by considering what fraction the first quantity is of the second. The fraction may be either proper or improper according to the value of the ratio.

The ratio may be expressed in either of two forms: e.g., the ratio of 4*d.* to 8*d.* may be written 4:8 (read "the ratio of 4 to 8") or $\frac{4}{8}$. These may be reduced to 1:2 or $\frac{1}{2}$.

Similarly the ratio of 1 lb. 4 oz. to 12 oz. may be written 20:12 or $\frac{5}{3}$. These may be reduced to 5:3 or $\frac{5}{3}$.

Note that the quantities compared must be of the same kind. We cannot express a ratio between pounds and inches.

Ex. 1. Express the ratio 1 yd. 2 ft. 6 in. to 2 yd. 1 ft. 6 in. in its simplest form.

$$\frac{1 \text{ yd. } 2 \text{ ft. } 6 \text{ in.}}{2 \text{ yd. } 1 \text{ ft. } 6 \text{ in.}} = \frac{5\frac{1}{2} \text{ ft.}}{7\frac{1}{2} \text{ ft.}} = \frac{11}{15} \text{ or } 11:15.$$

Ex. 2. If the ratio of £1. 7*s.* 6*d.* to £2. 12*s.* 6*d.* is the same as that of 33 to x , find x .

$$\frac{£1. 7s. 6d.}{£2. 12s. 6d.} = \frac{£1\frac{3}{8}}{£2\frac{5}{8}} = \frac{11}{21}.$$

$$\therefore \frac{11}{21} = \frac{33}{x}.$$

$$\text{But} \quad \frac{11}{21} = \frac{33}{63}. \quad \therefore x = 63.$$

46. Proportion.

When a statement is made of the equality of two ratios we obtain a proportion,

$$\text{e.g. } \frac{5}{7} = \frac{15}{21} \text{ or } 5:7 = 15:21 \text{ or } 5:7 :: 15:21.$$

Four quantities are said to be in proportion if the ratio of the first to the second is equal to that of the third to the fourth.

Ex. 1. If 5·7, 3·8, 16 and x are in proportion, find x .

$$\frac{5\cdot7}{3\cdot8} = \frac{16}{x}.$$

$$\therefore \frac{57}{38} = \frac{16}{x} \text{ or } \frac{3}{2} = \frac{16}{x}. \quad \therefore 3x = 32 \text{ or } x = 10\frac{2}{3}.$$

Second method :

$$\frac{5\cdot7}{3\cdot8} = \frac{16}{x}.$$

$$\therefore x \times 5\cdot7 = 16 \times 3\cdot8 \text{ (multiplying both sides by } 3\cdot8 \times x),$$

$$x = \frac{16 \times 3\cdot8}{5\cdot7}.$$

Note that 5·7 and x are called the *extremes* of the proportion, and 3·8 and 16 are called the *means*.

We have seen above that *the product of the extremes is equal to the product of the means*.

Ex. 2. If $\frac{3}{5}$ of a sum of money is £1. 16s., what is $\frac{4}{9}$ of it?

$\frac{4}{9}$ bears the same relation to $\frac{3}{5}$ as our answer does to £1. 16s., or

$$\frac{\frac{4}{9}}{\frac{3}{5}} = \frac{x}{\text{£1. 16s.}}.$$

$$\therefore \frac{3}{5}x = 36 \times \frac{4}{9} \text{ shillings,}$$

$$x = \frac{5}{3} \times 36 \times \frac{4}{9} \text{ shillings}$$

$$= 80 \text{ s.} = \text{£1. 6s. 8d.}$$

47. The Unitary Method of Proportion.

Ex. 1. If 3 lb. 15 oz. of material costs 7s. 10½d., what is the cost of 4 lb. 13 oz.?

I.e. we know the cost of 63 oz. and wish to find the cost of 77 oz. The latter would be simple if we knew the price of 1 oz. This can easily be found by dividing 7s. 10½d. by 63.

The method used below is called the *Unitary* method because the price or equivalent of a *unit* is found as an intermediate stage.

Statement.

$$\begin{aligned}
 3 \text{ lb. } 15 \text{ oz. costs } 7s. \ 10\frac{1}{2}d., \\
 1 \text{ oz. costs } \frac{7s. \ 10\frac{1}{2}d.}{63} . \\
 4 \text{ lb. } 13 \text{ oz. costs } \frac{7s. \ 10\frac{1}{2}d. \times 77}{63} \\
 = \frac{94\frac{1}{2} \times 77}{63} d. \\
 = \frac{21}{2} \times \frac{11}{8} d. \\
 = 2\frac{3}{2}d. = 115\frac{1}{2}d. \\
 = 9s. \ 7\frac{1}{2}d.
 \end{aligned}$$

When sufficient practice has been secured in using the unitary method, the middle line should be omitted, and the procedure is as follows:

$$\begin{aligned}
 3 \text{ lb. } 15 \text{ oz. costs } 7s. \ 10\frac{1}{2}d. \\
 4 \text{ lb. } 13 \text{ oz. will cost } more.
 \end{aligned}$$

$$\text{The cost will be } 7s. \ 10\frac{1}{2}d. \times \frac{77}{63}.$$

Note. It is important to ask the question: “*Will the answer be greater or less than the given quantity?*”

Ex. 2. 18 men do a piece of work in 24 days. How long will 12 men take to do it?

$$\begin{aligned}
 18 \text{ men do work in } 24 \text{ days.} \\
 12 \text{ men will take } longer.
 \end{aligned}$$

$$\text{The time will be } \frac{18}{12} \times 24 \text{ days, i.e. } 36 \text{ days.}$$

Ex. 3. Three men put £1250, £1750 and £2000 into a business. How should they share profits of £15,000?

$$A \text{ puts in } \frac{1250}{1250 + 1750 + 2000} \text{ of the whole,}$$

$$\therefore \text{ his profits are } \frac{1250}{5000} \text{ of the whole,}$$

$$\text{i.e. } \frac{1250}{5000} \times 15,000 \text{ or } \pounds 3750.$$

$$B's \text{ profits are } \frac{1750}{5000} \times 15,000 \text{ or } \pounds 5250.$$

$$C's \text{ profits are } \frac{2000}{5000} \times 15,000 \text{ or } \pounds 6000.$$

Ex. 4. A bankrupt can only pay £156 out of a debt of £224. How much does he pay in the £?

On 224 he pays 156.

On 1 he pays $\text{£}\frac{156}{224}$, or about 13s. 11d. in the £.

Ex. 5. If 3 men working 8 hours a day do a piece of work in 10 days, how long will 5 men take working 6 hours a day?

(a) *Method 1.*

3 men do it in 80 hours.

5 men do it in *less* time.

$$\frac{3}{5} \times 80 = 48 \text{ hours.}$$

\therefore no. of days is 8.

(b) *Method 2.*

3 men working at a certain rate take 10 days.

\therefore 5 men take $\frac{3}{5} \times 10$ or 6 days at the same rate.

At 8 hours a day 3 men take 6 days.

At 6 hours a day they take *longer*, $\therefore \frac{8}{6} \times 6$ days, or 8 days.

These two processes are usually combined.

Statement.

3 men 8 hours a day 10 days.

5 men 6 hours a day ?

$$10 \times \frac{3}{5} \times \frac{8}{6} \\ = 8 \text{ days.}$$

Note. In setting out the statement, the quantity of the type required in the answer is always placed on the right for convenience.

Ex. 6. Reduce a speed of 45 miles an hour to feet per second.

In 1 hr. 45 miles.

$$1 \text{ sec. } \frac{45 \times 1760 \times 3}{3600} \text{ ft.}$$

$$= 66 \text{ ft. per sec.}$$

Note. It is clear from the above examples that ratio and proportion present no new problems. They are merely exercises in simple fractions.

EXERCISE 21 (a). MENTAL.

In each of the following express the first quantity as the ratio of the second, in its simplest form:

1. 15 to 24.
2. 20 to 30.
3. $\frac{1}{2}$ to $\frac{1}{4}$.
4. $\frac{3}{4}$ to $\frac{5}{8}$.
5. 24 to 6.
6. 400 to 1600.
7. 10,000 to 500.
8. $1\frac{2}{3}$ to 3.
9. $3\frac{1}{2}$ to 7.
10. $2\frac{1}{4}$ to $1\frac{1}{2}$.
11. 5 to $\frac{1}{5}$.
12. $2\frac{1}{3}$ to $3\frac{1}{2}$.
13. 1.5 to 3.
14. 2.4 to 3.6.
15. $1\frac{1}{2}$ to 2.5.
16. 3.2 to 4.8.
17. 6*d.* to $3\frac{1}{2}$ *d.*
18. 1*s.* 6*d.* to 4*s.* 6*d.*
19. $6\frac{1}{2}$ *d.* to 2*s.* 8*d.*
20. £1. 10*s.* to £2. 10*s.*
21. 1 lb. to 1 lb. 8 oz.
22. 1 ton 10 cwt. to 3 tons.
23. 3 min. 30 sec. to 5 min.
24. 15 m. to 30 cm.
25. $1\frac{1}{2}$ Km. to 200 m.
26. 1 f. 40 c. to 4 f. 20 c.
27. 1 dollar 10 c. to 4 dollars 10 c.
28. $\frac{2}{3}$ of £5 to $\frac{1}{3}$ of £10.
29. $\frac{1}{2}$ of $\frac{1}{3}$ to $\frac{2}{3}$ of $\frac{1}{4}$.
30. 5 to 40.

Find x in each of the following:

31. $3 : 5 = 18 : x$.
32. $5 : 7\frac{1}{2} = 10 : x$.
33. $\frac{5}{100} = \frac{x}{20}$.
34. $\frac{5}{x} = \frac{75}{15}$.
35. $\frac{x}{6} = \frac{40}{120}$.
36. $\frac{x}{5} = \frac{20}{x}$.

37. If 10 lb. costs 2*s.* 6*d.*, what will 1 lb. cost? Hence what will 7 lb. cost?

38. If 5 yd. of material costs 3*s.* 6*d.*, what will 10 yd. cost?

39. If 3 lb. 6 oz. of flour is worth 1*s.*, what is 6 lb. 12 oz. worth?

40. What multiplier will change the cost of 5 lb. into the cost of 17 lb.?

41. What multiplier will change the cost of 2 lb. 8 oz. into the cost of 1 lb. 8 oz.?

42. If 4 men earn £24 in a certain time, what will 6 men earn in the same time?

43. If 4 yd. 24 in. of material costs 16*s.* 6*d.*, what will 7 yd. cost?

(Notice that 7 yd. = half as much again as 4 yd. 24 in.)

44. If 3 lb. of soap costs 2s. 3d., what will 3 dozen lb. cost?
45. What will 96 articles cost at 4s. 9d. per dozen?
46. How many miles can I go in 7 hr. 30 min. at the rate of 5 miles an hour?
47. If $\frac{2}{5}$ of my money is £240, what is the whole?
48. If 5 men do a piece of work in 10 days, how long will 2 men take?
49. If one tap fills a cistern in 20 minutes and another empties it in 30 minutes, how much of the cistern will be filled in 20 minutes if both taps are open together?
50. If 9 men reap a field in 12 hours, how many men would take 18 hours to do it, working at the same rate?

EXERCISE 21 (b).

Find the value of x in each of the following:

1. $55:3 = 192\cdot5:x$.
2. $5\frac{1}{2}:4 = 7\frac{1}{2}:x$.
3. $2\cdot53:3\cdot12 = 6\cdot15:x$ [correct to 2 places].
4. $45:17 = 72:x$.
5. $5\cdot5:x = 7\cdot7:9\cdot9$.
6. $42:63 = x:75$.
7. 1 lb. 2 oz.: 2 lb. 2 oz. = $3:x$.
8. $5\frac{1}{2}$ yd.: 2 yd. 1 ft. 6 in. = £2. 15s.: x .
9. £9:£2. 10s. = 18 yd.: x yd.
10. $3:x = \text{£}1. 5s. 6d. : \text{£}2. 10s. 6d.$
11. What is the cost of 3·4 ounces at 3s. 4d. a lb.?
12. If pencils cost $7\frac{3}{4}$ d. a dozen, how many can be bought for £1. 5s. 10d.?
13. If 32 acres cost £1000, what will 84 acres cost?
14. What is the cost of 18 quarts at £5 for 48 gallons?
15. If a ton of coal costs £2. 5s., what will 13 cwt. cost?
16. What is the cost of 2 miles of wire at the rate of 9d. for 20 yards?

17. If 16 lb. costs 2s. 6d., how many cwt. can be bought for £168?

18. I spend $\frac{2}{3}$ of my money, and then $\frac{3}{7}$ of the remainder, and have 1s. 8d. left. How much had I at first?

19. Divide 938 in the ratio of $4\frac{1}{3}$ to $3\frac{1}{4}$.

20. How many litres can I buy for 1000 francs at the rate of 80 francs per Hectolitre?

21. How many $7\frac{1}{2}d.$ toys cost as much as 200 at 9d. each?

22. $\frac{4}{7}$ of a sum of money is £1. 4s. What is $\frac{7}{12}$ of the same sum?

23. Find the cost of 29,200 c. ft. of gas at 3s. 4d. per 1000 c. ft.

24. What is the cost of 5 gross of articles at 15s. per 100?

25. What is the cost of 56 Hectometres at 1 f. 25 c. for 20 cm.?

26. Find the charge for 59 lb. at the rate of 2s. 4d. per cwt.

27. A rate of 1s. 8d. in the £ produces £1560. What will be produced when the rate is 2s. 1d. in the £?

28. Divide 27s. 6d. among three boys in proportion to their ages, which are 9 years, 11 years, 13 years.

29. How long should 24 men take to finish a piece of work of which 18 men have done half in 15 days?

30. Brass is composed of seven parts of copper and three of spelter. Copper costs £2 a cwt., spelter £1. 0s. 6d. a cwt. What will be the cost of the materials for $5\frac{1}{2}$ tons of brass?

31. What will 7 yards cost if 2 shillings buys $\frac{8}{9}$ of $\frac{1}{8}$ of a yard?

32. If 18 men can plough 24 acres in 7 days, how many will be needed to plough the same in 21 days?

33. If a train running at $47\frac{1}{2}$ miles an hour takes 1 hour 36 minutes on a journey, how long would it take if its speed was increased by $3\frac{1}{4}$ miles an hour?

34. A train travelled between Braunston and Charwelton, a distance of 7 miles, in 5 minutes 50 seconds. What was the average speed in miles an hour?

35. *A*, *B* and *C* turn 20, 30 and 70 sheep respectively into a pasture which they rent for £21. What should each pay?

36. A man bought £15 worth of francs when they were 68·5 to the pound. He spent 600 francs and changed the remainder into English money at 75 francs to the pound. How much money did he receive?

37. If 1650 men make 15 miles of railway in 3 months, how long will it take 1375 men, working at the same rate, to make 75 miles?

38. If 5 men cut out 1260 chair legs in $10\frac{1}{2}$ days, how many days will 6 men take to cut out 1200 chair legs, working at the same rate?

39. A certain area of ground can be ploughed by 7 motor ploughs in 21 days. How long will 5 such machines take to plough twice as much ground?

40. Find the weight in lbs. of a quarter of a mile of wire of which 5 feet weigh $4\frac{1}{2}$ ounces.

PERCENTAGES

48. In the previous exercise it was shown how two quantities could be compared by expressing one as the *ratio* or *fraction* of the other.

But having obtained the ratio of one quantity to another, it is not always easy to see the connection between this ratio and another.

E.g. the ratio of 3 oz. to 4 oz. is $\frac{3}{4}$,

and the ratio of 3 oz. 4 dr. to 4 oz. 1 dr. is $\frac{52}{65}$ or $\frac{4}{5}$.

What relation is there between $\frac{3}{4}$ and $\frac{4}{5}$?

The difficulty is overcome by using a definite standard, namely 100, for the comparison:

thus 3 oz. compared with 4 oz. is the same as 75 oz. compared with 100 oz.,

and 3 oz. 4 dr. compared with 4 oz. 1 dr. is the same as 80 oz. compared with 100 oz.

Since we are using 100 as the standard of comparison and *centum* is the Latin word for 100, we say that 3 oz. is 75 *per centum*, or, in its abbreviated form, 75 *per cent.* or 75 % of 4 oz. So 3 oz. 4 dr. is 80 *per cent.* of 4 oz. 1 dr.

Further examples:

(a) 1 per cent., or, as it is usually written, 1 %, of £5 is 1 part in every 100 of £5, or $\frac{1}{100}$ of £5, i.e. 1s.

(b) 5 % of 3 lb. 2 oz. is 5 per 100, or $\frac{5}{100}$ of 3 lb. 2 oz., i.e. $2\frac{1}{2}$ oz.

49. Percentages can be expressed as equivalent fractions in lowest terms:

$$12\frac{1}{2}\% = \frac{12\frac{1}{2}}{100} = \frac{25}{200} = \frac{1}{8}.$$

$$6\frac{2}{5}\% = \frac{6\frac{2}{5}}{100} = \frac{32}{500} = \frac{8}{125}.$$

$$\frac{1}{4}\% = \frac{\frac{1}{4}}{100} = \frac{1}{400}.$$

It is a simpler matter to change a percentage into an equivalent decimal, for we simply divide it by 100:

$$24\frac{1}{4}\% = 24.25 \div 100 = .2425.$$

The following equivalents, amongst others, should be learnt by heart:

| | | |
|-----------------------|----------------------------------|---------------------------------|
| $1\% = \frac{1}{100}$ | $21\frac{1}{2}\% = \frac{1}{40}$ | $3\frac{1}{3}\% = \frac{1}{30}$ |
| $2\% = \frac{1}{50}$ | $7\frac{1}{2}\% = \frac{3}{40}$ | $6\frac{2}{3}\% = \frac{1}{15}$ |
| $4\% = \frac{1}{25}$ | $12\frac{1}{2}\% = \frac{1}{8}$ | $16\frac{2}{3}\% = \frac{1}{6}$ |
| $5\% = \frac{1}{20}$ | $6\frac{1}{4}\% = \frac{1}{16}$ | $33\frac{1}{3}\% = \frac{1}{3}$ |
| $10\% = \frac{1}{10}$ | | $66\frac{2}{3}\% = \frac{2}{3}$ |
| $20\% = \frac{1}{5}$ | | |
| $25\% = \frac{1}{4}$ | | |
| $50\% = \frac{1}{2}$ | | |
| $75\% = \frac{3}{4}$ | | |

50. Common Applications of Percentages.

1. Teachers commonly reduce marks in examination papers to percentages; e.g. they may give marks to a total of 50 and then double all of them so as to represent percentages.

2. The attendances on a school register are always reduced to percentages, e.g. a class is sometimes said to have a good attendance for the week if the attendances amount to over 90%.

Note. The attendance cannot be more than 100%.

3. Shopkeepers always calculate their profits on a percentage basis.

Note. In most school sums, the calculation is made by considering the profit on the cost price.

E.g. If I buy for £1 and sell for £1. 5s., I make 25% profit, i.e. at the rate of £25 in £100.

But the shopkeeper, in making a profit of 5s. with a *selling* price of £1. 5s., usually says that he is making a profit of 20% *on turnover*.

4. In government and other investments, a percentage of the value of the loan is offered as *Interest*. The Post Office Savings Bank, for example, pays $2\frac{1}{2}\%$ every year on the money invested.

5. The commercial traveller is often allowed *Discount* at a certain rate per cent. on all his sales.

6. Insurance *Premiums*, i.e. the money paid to ensure the payment of a certain sum at death, or after a certain number of years, are calculated on a percentage basis.

7. Shopkeepers often allow a *Discount* off bills for a cash payment at a given percentage; 5% is a common rate; i.e. 1s. in the £.

Note. When the fractional or decimal values of the percentages have been found, examples in percentages are little more than applications of the simple rules of fractions and decimals.

51. Examples in Percentages:

Ex. 1. Reduce $3\frac{3}{4}\%$ to an equivalent fraction in lowest terms, and to a decimal.

$$3\frac{3}{4}\% = \frac{3\frac{3}{4}}{100} = \frac{\overset{3}{1}\cancel{3}}{4 \times \overset{20}{1}\cancel{0}\cancel{0}} = \frac{3}{80}.$$

$$3\frac{3}{4}\% = 3.75\% = .0375.$$

Ex. 2. What percentage is equivalent to the fraction $\frac{17}{63}$?

$$\frac{17}{63} = \frac{17 \times 100}{63} \%.$$

$$= \frac{1700}{63} = 26\frac{62}{63}\%.$$

Ex. 3. Find 4.35% of £8. 6s. 8d.

4.35% of £8. 6s. 8d.

$$= \frac{£4.35}{100} \times 8\frac{1}{2} = \frac{\overset{29}{1}\cancel{4}\cancel{3}\cancel{5}}{\overset{20}{1}\cancel{0}\cancel{0} \times \overset{4}{1}\cancel{0}\cancel{0}} \times \frac{\overset{2}{2}\cancel{9}}{\cancel{2}} = £\frac{29}{80} = 7s. 3d.$$

Ex. 4. What percentage is £1. 7s. 6d. of £3 5s.?

$$\frac{£1. 7s. 6d.}{£3. 5s.} = \frac{27\frac{1}{2}}{65} = \frac{\overset{11}{5}\cancel{5}}{\overset{2}{2} \times \overset{50}{5}\cancel{0}} \times \overset{100}{1}\cancel{0}\cancel{0} \text{ per cent.}$$

$$= \frac{550}{13}\% = 42\frac{4}{13}\%.$$

Ex. 5. What is the commission on sales amounting to £1250, at the rate of $3\frac{1}{4}\%$?

$$3\frac{1}{4}\% \text{ of } £1250 = \frac{3\frac{1}{4}}{100} \times 1250 = \frac{13}{4} \times \frac{1250}{100} = \frac{325}{8} = £40. 12s. 6d.$$

Ex. 6. A man buys goods at 5s. 6d. a dozen and sells them at the rate of 20 for 12s. 6d. What percentage profit does he make?

Note. In order to find $\%$ profit we must discover first:

1. The cost price of 1 article or a definite number of articles.

2. The selling price of 1 article or the *same* number of articles.

$$5s. 6d. \text{ per doz.} = 1 \text{ for } 5\frac{1}{2}d.$$

$$20 \text{ for } 12s. 6d. = 1 \text{ for } 7\frac{1}{2}d.$$

\therefore Profit on $5\frac{1}{2}d.$ is $2d.$,

$$\begin{aligned} \text{on } 100 \text{ it is } & \frac{2 \times 100}{5\frac{1}{2}} \\ & = \frac{200 \times 2}{11} = \frac{400}{11} = 36\frac{4}{11}\%. \end{aligned}$$

Ex. 7. 20% is lost by selling an article for £8. 8s. What $\%$ is lost or gained by selling it for £12. 10s.?

Let 100 represent the cost price.

Then 80 represents the first selling price.

£8. 8s. represents 80.

$$\begin{aligned} \therefore \text{£12. 10s.} & \quad \frac{80 \times \text{£12. 10s.}}{\text{£8. 8s.}} \\ & \quad \frac{10}{88 \times 250} = \frac{2500}{21} = 119\frac{1}{21}. \end{aligned}$$

\therefore the $\%$ gain is $19\frac{1}{21}$.

EXERCISE 22 (a). MENTAL.

Reduce the following percentages to fractions in their lowest terms:

- | | | | |
|------------------------|------------------------|-----------------------|------------------------|
| 1. 5% . | 2. 10% . | 3. 2% . | 4. 20% . |
| 5. 4% . | 6. 25% . | 7. 50% . | 8. $33\frac{1}{3}\%$. |
| 9. $66\frac{2}{3}\%$. | 10. 75% . | 11. 100% . | 12. 200% . |
| 13. $3\frac{1}{3}\%$. | 14. $6\frac{2}{3}\%$. | 15. $\frac{1}{4}\%$. | |

What percentages are equivalent to the following fractions?

- | | | | | |
|---------------------|-----------------------|------------------------|----------------------|----------------------|
| 16. $\frac{1}{5}$. | 17. $\frac{1}{10}$. | 18. $\frac{1}{4}$. | 19. $\frac{1}{3}$. | 20. $\frac{2}{3}$. |
| 21. $\frac{3}{4}$. | 22. $\frac{17}{50}$. | 23. $\frac{19}{200}$. | 24. $1\frac{1}{4}$. | 25. $2\frac{1}{5}$. |

What percentages are equivalent to the following decimals?

- | | | | | |
|----------|----------|-----------|-----------|------------|
| 26. .03. | 27. .15. | 28. .075. | 29. 5.25. | 30. .0025. |
|----------|----------|-----------|-----------|------------|

Find the equivalents to the following:

- | | |
|--|--|
| 31. 5% of £50. | 32. 15% of £18. 10s. |
| 33. 2s. 6d. expressed as a percentage of £1. | |
| 34. $5\frac{1}{2}$ as a percentage of 400. | |
| 35. 15% of 5s. | 36. $36\frac{2}{3}\%$ as a percentage of 55. |
| 37. 17% of £5. | 38. $12\frac{1}{2}\%$ of £18. 4s. |
| 39. $16\frac{2}{3}\%$ of £73. 10s. | 40. 25% of £1. 16s. 2d. |

In the following examples, what percentage is the first quantity of the second?

- | | |
|--|------------------------------|
| 41. £15 of £75. | 42. 1 lb. 4 oz. of 5 lb. |
| 43. $\frac{1}{4}$ of $2\frac{1}{2}$. | 44. 6s. 6d. of 10s. |
| 45. 1 min. 20 sec. of 3 min. 20 sec. | 46. £5 of £15. |
| 47. 346 of 800. | 48. 1 ton 15 cwt. of 5 tons. |
| 49. $3\frac{1}{4}$ of $6\frac{1}{4}$. | 50. £1. 7s. 6d. of £2. 10s. |

51. A traveller receives commission at the rate of 15% . What commission will he receive on sales amounting to £125?

52. An article bought for £1. 15s. 6d is sold at a loss of $33\frac{1}{3}\%$. What is the actual loss?

53. The population of a certain town in January 1926 was 351,200, to the nearest hundred. During 1926 it increased by 5% . What was the increase, to the nearest hundred, during 1926?

54. $66\frac{2}{3}\%$ of the population of a town is 60,000. What is the whole population?

55. What is the dividend on £650 at the rate of 5% ?

56. I owe £55 and can pay £44. What percentage remains to be paid?

57. If £210 represents 5% increase on a certain sum, what was that sum?

58. If I lose 25% of my money I shall have £750 left. What sum have I?

59. A horse-dealer had 250 horses in 1910 and has only 25 now. By what percentage has his stable decreased?

60. Goods costing £155 are sold for £186. What is the percentage profit?

EXERCISE 22 (b).

Reduce the following percentages to fractions in their lowest terms:

1. $65\frac{1}{3}\%$. 2. $42\frac{2}{5}\%$. 3. $13\frac{1}{3}\%$. 4. $2\frac{3}{10}\%$. 5. $4\frac{2}{9}\%$.
 6. $106\frac{2}{3}\%$. 7. $222\frac{1}{2}\%$. 8. $166\frac{2}{3}\%$. 9. $2\cdot625\%$. 10. $\cdot0725\%$.

What percentages are equivalent to the following fractions and decimals?

11. $\frac{438}{1500}$. 12. $\frac{17}{24}$. 13. $\frac{15}{17}$. 14. $\frac{12}{13}$. 15. 1·0245.
 16. 7·1285. 17. $1\frac{1}{9}$. 18. $2\frac{2}{3}$. 19. $1\frac{1}{2}$. 20. $1\frac{3}{22}$.

Find the equivalents of the following:

21. $14\cdot4\%$ of 250. 22. $8\frac{3}{4}\%$ of £1.
 23. $\frac{3}{4}\%$ of 600. 24. $28\frac{1}{2}\%$ of £40.
 25. $5\frac{5}{9}\%$ of £5. 15s. 6d. 26. $3\frac{1}{3}\%$ of £45.
 27. 5% of £217. 15s. 28. $8\cdot2\%$ of 75.
 29. 15% of $7\frac{1}{2}$ yd. in inches. 30. $6\cdot95\%$ of £4. 3s. 4d.

In the following examples what percentage is the first of the second?

31. 42 lb. of 1 cwt. 32. 10s. of £3. 6s. 8d.
 33. $3\frac{1}{2}$ d. of $7\frac{1}{2}$ d. 34. 16s. 6d. of 36s.
 35. 57 of 304. 36. 18 of 288.
 37. £867 of £850. 38. £7. 10s. of £42. 10s.
 39. 2s. $7\frac{1}{2}$ d. of 7s. 40. 9d. of 16s. 8d.

EXERCISE 22 (c).

1. Find the increase per cent. when wages are raised from 55s. to 75s. per week.
2. What is the "brokerage" at $\frac{1}{8}\%$ on £9850?
3. What is the gain per cent. if articles are bought at 1s. 9d. each and sold at 2s. 3d. each?
4. What is the cash price of an article marked 25 guineas if a discount of 3% is allowed during a sale?
5. What is the gain per cent. when articles costing 36s. each are sold for £2. 12s. 6d. each?
6. What is the commission on £6870 at the rate of $1\frac{1}{4}\%$?
7. A house cost £850 and is sold so as to gain 20% . What is the selling price?
8. What is the premium on £7500 at $\frac{5}{8}\%$?
9. What is the net value of a 5% dividend on £350, when income tax at 3s. 6d. in the £ has been deducted?
10. Goods bought for £5. 15s. are sold at a loss of 5% . What is the selling price?
11. Goods bought for 16s. 8d. are sold for 17s. 5d. What is the gain per cent.?
12. A grocer buys eggs at 7d. per dozen and sells them at 16 a shilling. Find his profit per cent.
13. A man buys apples at £2. 13s. 4d. a thousand and sells them at 7 for 6d. What does he gain or lose per cent.?
14. A tradesman sells three-quarters of his stock of a certain article at a gain of 30% , and the remainder at a loss of 10% . What is his percentage of profit on the whole?
15. 24% is gained by selling goods for £46. 10s. What was the cost price?
16. What is the cost of a gross of articles at 15s per doz., less 25% , and 5% of that reduced price for cash?
17. Nails bought at 32s. per cwt. are sold at $4\frac{1}{2}d.$ per lb. What is the gain per cent.?
18. A house cost £625. What is the selling price if there is a loss in selling of $7\frac{1}{4}\%$?

19. Articles bought at the rate of 44 for 1s. are sold at 36 for 1s. What is the gain per cent.?

20. Goods are sold for £4. 18s. 7d. at a loss of 9%. Find the cost price.

21. If the goods in Question 20 are sold at a gain of 9%, what is the increase in selling price?

22. A tradesman sells articles costing £262. 4s., and makes a profit of 5% on the "turnover." What is the selling price?

23. If an article is sold for £13. 4s., the gain is 10%. If it is sold for £13. 16s., what is the gain per cent.?

24. I gain 10% by selling an article for 14s. 8d. What will be the gain per cent. if I sell it for 15s.?

25. What is my percentage loss or gain if I buy articles at the rate of 7½d. a dozen and sell them at 7 for 6d.?

26. A buyer is offered a choice of a discount of 8% or a penny in the shilling. What would be the difference in paying an account of £55?

27. The publisher of a book sold at 10s. 6d. net agrees to pay the author a royalty of 15% of the receipts, but he reckons 25 books as 24 in estimating the receipts. If 1500 copies of the book are sold, find how much is due to the author.

28. The market price of eggs at a certain date was 35s. per 120. A year earlier it was 24s. per 120. What was the increase per cent.?

29. Cheese bought at 161s. per cwt. is sold at 1s. 8d. per lb. Find the gain per cent.

30. On a certain job a decorator charged £12. 10s. for labour and 5 guineas for material. Find the total cost of a similar job when wages have fallen 6½% and the price of material has been reduced by 10%.

31. In 40 weeks the rent due from 18 houses was £630. What would be the average weekly rental of each house if it were increased by 40%?

32. Goods are sold to give a profit of 3½d. in every shilling of the outlay. What will goods costing £20 be sold for, and what percentage profit does this represent?

33. A merchant bought 300 articles for £85. He sold $\frac{1}{3}$ at a loss of 25%, $\frac{1}{4}$ at a profit of 50%, and the remainder at a profit of 15%. What was the total profit?

34. A merchant buys 6 articles at £3. 3s. 4d. each, and 9 at £4. 10s. each. He sells the first lot at a profit of 30%, but the second lot is sold at 50% below cost price. What is the total gain or loss?

35. A merchant sold 30% of his stock of wheat, and then 25% of the remainder. He had 630 bushels left. What had he at first?

36. 30% is gained by selling an article for 9s. 9d. What percentage is gained by selling for 9s.?

SIMPLE INTEREST

52. If I borrow a sum of money for a certain period, I must expect to pay for the privilege of using the lender's money, and the longer I keep it the more I must pay. The sum of money paid to the lender for the use of his money is known as *Interest*. The sum borrowed is called the *Principal*.

Interest is always calculated as a percentage of the given sum, paid every year, and this is called the *Rate per cent. per annum*.

Simple Interest sums are therefore applications of the principles of percentages, and do not involve *new* rules or principles.

Suppose I borrow £525 for 4 years at $2\frac{1}{2}\%$.

I pay as interest £2½ on every £100 every year.

As I borrow $5\frac{1}{4}$ hundreds for 4 years, I must pay

$$£5\frac{1}{4} \times 4 \times 2\frac{1}{2};$$

$$\text{i.e. } \frac{21}{4} \times 4 \times \frac{5}{2} = 10\frac{5}{2} = £52. 10s.$$

Usually however, the number of £100 is not so easily calculated.

Ex. 1. Find the Interest on £176. 17s. 6d. for 3 years 6 months at $5\frac{1}{4}\%$ per annum.

Int. on £100 for 1 year = £5¼.

$$\begin{aligned} \therefore \text{Int. on } £176\frac{7}{8} \text{ for } 3\frac{1}{2} \text{ years} &= £5\frac{1}{4} \times 3\frac{1}{2} \times \frac{176\frac{7}{8}}{100} \\ &= £24\frac{1}{4} \times \frac{7}{2} \times \frac{1415}{800} \text{ etc.} \end{aligned}$$

Ex. 2. Find the Interest on £P for t years at $r\%$ per annum.

Int. on £100 for 1 year = £ r .

$$\begin{aligned} \therefore \text{Int. on } £P \text{ for } t \text{ years} &= £r \times t \times \frac{P}{100} \\ &= \frac{\text{Prt}}{100}. \end{aligned}$$

53. Transforming the Formula $I = \frac{\text{Prt}}{100}$.

This formula is very often used for finding Interest, but it is more useful for finding Principal, Rate per cent., or Time, when

the other values are known. For these purposes we can transform the formula as follows:

$$I = \frac{Prt}{100}.$$

$$\therefore 100I = Prt.$$

$$\therefore (1) P = \frac{100I}{rt};$$

$$(2) r = \frac{100I}{Pt};$$

$$(3) t = \frac{100I}{Pr}.$$

54. Sometimes the borrower is allowed to hold back the Interest until he can pay back Interest and Principal at the same time. This total is known as the *Amount*.

Finding Amount.

Ex. 1. Find the Amount of £1250 in 3 years at 4% Simple Interest.

Method 1.

Int. on £100 for 3 years at 4% = £12.

\therefore Amount of £100 = £112.

\therefore Amount of £1250 = £ $\frac{112 \times 1250}{100}$ = £1400.

Method 2.

Int. on £100 for 1 yr. = £12.

\therefore Int. on £1250 = £ $\frac{12 \times 1250}{100}$ = £150.

Amount = £1250 + £150 = £1400.

Ex 2. A man borrows a sum of money for 5 years at $2\frac{1}{2}\%$ and pays back £9000 at the end of the time to cover Principal and Interest. What was the amount borrowed?

Int. on £100 for 5 years at $2\frac{1}{2}\%$ = £12 $\frac{1}{2}$.

£112 $\frac{1}{2}$ is the amount for £100.

\therefore £9000 is the amount for $\frac{100 \times 9000}{112\frac{1}{2}}$
= £8000.

55. Finding Time of loan, Rate per cent., and Principal.

Ex. 1. In what time will £112. 10s. amount to £150 at 5% per annum?

Method 1.

Time for £100 to gain £5 = 1 year.

∴ Time for £112. 10s. to gain £37. 10s.

$$= \frac{37\frac{1}{2}}{5} \times \frac{100}{112\frac{1}{2}}$$

$$= \frac{7\frac{5}{10}}{10} \times \frac{200}{225} = 6\frac{2}{3} \text{ years.}$$

Note that £112½ will not take so long to gain £5.

Method 2.

$$I = \frac{Prt}{100}.$$

$$\therefore 100 I = Prt.$$

$$\therefore t = \frac{100 I}{Pr}$$

$$= \frac{100 \times 37\frac{1}{2}}{112\frac{1}{2} \times 5}$$

$$= \frac{20}{100} \times \frac{75}{2} \times \frac{2}{225} \times \frac{1}{5}$$

$$= 6\frac{2}{3} \text{ years.}$$

Ex. 2. What Principal will gain £27. 10s. interest in 5½ years at 2½%.

Method 1.

£2½ is gained in 1 year by £100.

$$\therefore \text{£}27\frac{1}{2} \quad \text{,,} \quad \text{,,} \quad 5\frac{1}{2} \text{ years by } 100 \times \frac{1}{5\frac{1}{2}} \times \frac{27\frac{1}{2}}{2\frac{1}{2}}$$

$$= 100 \times \frac{2}{11} \times \frac{55}{2} \times \frac{2}{5}$$

$$= \text{£}200.$$

Method 2.

$$I = \frac{Prt}{100}. \quad \therefore Prt = 100 I.$$

$$\therefore P = \frac{100 I}{rt}$$

$$= \frac{100 \times 27\frac{1}{2}}{2\frac{1}{2} \times 5\frac{1}{2}}$$

$$= 100 \times \frac{55}{2} \times \frac{2}{11} \times \frac{2}{5}$$

$$= \text{£}200.$$

56. Note. In calculating the number of days of the loan when the first and last days are given, *either the first or the last of these is usually included, but not both*, e.g.

From January 23rd to September 15th.

| | |
|---------|------------|
| Jan. 8 | June 30 |
| Feb. 28 | July 31 |
| Mar. 31 | Aug. 31 |
| Apr. 30 | Sept. 15 |
| May 31 | <u>235</u> |

It is useful to note that 73 days = $\frac{1}{5}$ of a year

| | |
|--------------------------|---|
| 146 days = $\frac{2}{5}$ | „ |
| 219 days = $\frac{3}{5}$ | „ |
| 292 days = $\frac{4}{5}$ | „ |

EXERCISE 23 (a). MENTAL.

Find the Simple Interest on the following for 1 year:

- | | |
|--------------------------------|-------------------------------|
| 1. £200 at 5%. | 2. £250 at 4%. |
| 3. £112. 10s. at 6%. | 4. £500 at $2\frac{1}{2}\%$. |
| 5. £750 at $12\frac{1}{2}\%$. | 6. £450 at 5%. |

Find the Simple Interest on the following for the periods and at the rates stated:

- | | |
|--|---------------------------|
| 7. £200 for 2 yr. at 5%. | 8. £300 for 4 yr. at 4%. |
| 9. £500 for 5 yr. at 6%. | 10. £250 for 4 yr. at 5%. |
| 11. £600 for 3 yr. at $2\frac{1}{2}\%$. | 12. £750 for 4 yr. at 5%. |

What are the Amounts at Simple Interest of the following?

- | | |
|---------------------------|--|
| 13. £200 for 1 yr. at 5%. | 14. £150 for 2 yr. at $2\frac{1}{2}\%$. |
| 15. £350 for 4 yr. at 5%. | 16. £725 for 4 yr. at 4%. |

17. Find the Simple Interest on £72 for 3 yr. at 5%.

18. At what Rate per cent. will £25 earn 10s. interest in 4 months?

19. Find the Interest on £36 for 8 months at $7\frac{1}{2}\%$.

20. What is the Interest on £45 for 36 weeks at the rate of $\frac{1}{2}d.$ in the £ per week?

21. The Simple Interest on £10 for 8 months is 8s. What is the rate per cent. per annum?
22. What is the charge for a loan of £730 for 83 days at 5% ?
23. What is the tax on a rental of £75 at the rate of 4s. in the £, if one-fifth of the rental is not taxed?
24. In what time will £150 gain £21 at 4% ?
25. In what time will £500 amount to £605 at 7% ?

EXERCISE 23 (b).

Find the Simple Interest and the Amount to the nearest penny on:

1. £500 for 8 months at 4% .
2. £175 for 9 months at 5% .
3. £325. 10s. for $2\frac{1}{2}$ years at 5% .
4. £725. 15s. for 3 years 9 months at 4% .
5. £835. 12s. 6d. for 5 years at $2\frac{1}{2}\%$.
6. £19. 12s. 6d. for 6 years at $7\frac{1}{2}\%$.
7. £162. 3s. 4d. for $3\frac{1}{4}$ years at $2\frac{1}{2}\%$.
8. £149. 12s. 6d. for $4\frac{1}{2}$ years at 4% .
9. £350. 13s. 4d. for 5 years 6 months at $4\frac{1}{2}\%$.
10. £730. 13s. 3d. for 2 years 6 months at $3\frac{1}{3}\%$.
11. £501. 15s. 7d. for 4 years 2 months at 6% .
12. £417 for 7 months at $2\frac{1}{2}\%$.
13. £142. 15s. for 1 year 7 months at $4\frac{3}{4}\%$.
14. £529 for 17 months at $5\frac{1}{4}\%$.
15. £719 for 65 days at 4% .
16. £887. 10s. for 93 days at $4\frac{1}{2}\%$.
17. £523. 15s. for 1 year 8 months at $5\frac{1}{4}\%$.
18. £927. 6s. for 55 days at 5% .
19. £650. 8s. for 5 months at $5\frac{1}{2}\%$.
20. £531 for $7\frac{1}{2}$ years at $4\frac{3}{4}\%$.

Find the "time" in each of the following. Note that either the actual Interest or the Amount is given in each case.

| Principal | Rate % | Interest | Amount |
|--------------------|----------------|---------------------------|------------------------------|
| 21. £360 | $2\frac{1}{2}$ | £31. 10s. | |
| 22. £375 | $7\frac{1}{2}$ | £90 | |
| 23. £525 | 5 | | £640. 10s. |
| 24. £720. 10s. | 4 | | £840. 11s. 8d. |
| 25. £535 | $2\frac{1}{2}$ | £60. 3s. 9d. | |
| 26. £500. 13s. 4d. | 4 | £50. 1s. 4d. | |
| 27. £133. 6s. 8d. | $5\frac{1}{2}$ | | £192 |
| 28. £425 | $4\frac{3}{4}$ | £8. 8s. $2\frac{3}{4}$ d. | |
| 29. £237. 10s. | $2\frac{1}{2}$ | £3. 3s. 4d. | |
| 30. £456. 5s. | $2\frac{1}{2}$ | | £476. 15s. $7\frac{1}{2}$ d. |

What Rate per cent. is charged in each of the following?

| Principal | Time | Interest | Amount |
|--------------------|------------------|----------|------------------------------|
| 31. £75 | 9 months | £4. 10s. | |
| 32. £85 | 73 days | 8s. 6d. | |
| 33. £25 | 3 years | £4. 10s. | |
| 34. £515. 10s. | 4 years | | £618. 12s. |
| 35. £295. 12s. 6d. | 3 years 9 months | | £339. 19s. $4\frac{1}{2}$ d. |

Find the Principal in each of the following:

| Rate % | Time | Interest |
|--------------------|------------------|---------------|
| 36. $2\frac{1}{2}$ | 4 years | £56 |
| 37. 3 | 2 years 4 months | £113. 15s. |
| 38. $3\frac{1}{2}$ | 4 years | £74. 2s. |
| 39. 5 | 3 years 6 months | £48. 16s. 6d. |
| 40. 5 | 2 years 8 months | £97. 13s. 4d. |

Find the Principal in each of the following:

| Rate % | Time | Amount |
|--------------------|------------------|----------------|
| 41. $2\frac{1}{2}$ | 4 years | £3905 |
| 42. 5 | 3 years | £1468. 3s. 4d. |
| 43. 4 | 3 years 6 months | £291. 8s. 3d. |
| 44. $2\frac{1}{2}$ | 5 years | £637. 17s. 6d. |
| 45. 4 | 6 years 3 months | £266. 18s. |

EXERCISE 23 (c).

1. A man borrowed a sum of money and paid 2s. a week interest. If the interest was calculated at 5% per annum, what sum did he borrow?

2. A man who borrowed £216. 13s. 4d. agreed to pay interest at a certain rate. At the end of 292 days he repaid the money, together with interest for the time, a total of £224. 9s. 4d. At what rate per cent. per annum did he borrow?

3. The Simple Interest on £1875. 12s. 6d. for eight months is £56. 5s. $4\frac{1}{2}$ d. What is the rate per cent.?

4. The Simple Interest for 4 years on £55. 16s. 8d. is £8. 13s. 1d. At what rate per cent. per annum was the Interest charged?

5. A man borrowed £525. 16s. 8d. for 1 year 3 months at $4\frac{1}{2}\%$ per annum. If he repaid the loan 5 months before it was due, how much did he save in Interest?

6. If the interest on £x for 8 months at 5% per annum was £4. 3s. 4d., what amount did x represent?

7. On 1st March, 1920, a person borrows £219 at 4% per annum, Simple Interest. An arrangement is made that the principal and interest shall be repaid on the day it amounts to £225. When will the loan and interest have to be repaid?

8. A man borrowed £1095 on February 5th, 1919, and repaid it 273 days later, with interest at $5\frac{1}{4}\%$ per cent. What amount did he pay, to the nearest shilling?

9. On January 10th, 1928, you lent a friend £280 at 6% per annum, and on May 10th, 1928, you lent him a further £120 at 5% per annum. How much interest should he have paid on July 10th, 1928?

10. A lad put 17s. 6d. in a Savings Bank paying $2\frac{1}{2}\%$ Simple Interest, and withdrew it with interest in 8 years. What sum did he withdraw?

11. A man borrows £720 on January 1st, 1923. Six months later he repays the loan together with interest, making a total of £738. 18s. 0d. At what rate per cent. per annum was he charged?

12. A certain sum is borrowed for 6 years at $3\frac{1}{2}\%$ per annum, and at the end of that time the Principal and Interest amounted to £2016. 13s. 4d. What sum was borrowed?

13. National Savings Certificates are issued at 16s. each, amounting in 5 years to £1 and in 10 years to 26s. Calculate the rate per cent. per annum at Simple Interest allowed on these Certificates at the end of (a) 5 years, (b) 10 years.

14. A man has £450 on deposit account at a Bank at 2 % per annum. He deposited on the 15th November and withdrew on the following 19th February. How much interest was due? (Answer to nearest penny.)

15. A borrower pays £723. 5s. in settlement of Principal and Interest on a loan for 7 years at $4\frac{1}{2}$ % per annum Simple Interest. What was the sum advanced?

16. A man placed £550 on deposit on the 2nd of March in a certain year and withdrew it with interest on the 5th of July of that year. If the rate of interest was 3 % per annum, what amount did he receive?

17. Find to the nearest penny the Simple Interest on £750 at $3\frac{1}{2}$ % per annum from January 10th, 1928, to December 8th, 1928.

18. A man borrows £60 on July 1st and repays it on September 29th. What interest does he pay, interest being charged at the rate of 6 % per annum?

COMPOUND INTEREST

57. The kind of Interest with which we have been dealing is known as *Simple Interest* to distinguish it from what is called *Compound Interest*. Two simple examples will show the difference:

1. Suppose I lend £100 to the Government for a loan paying 5%/. At the end of every half year £2. 10s. interest will be sent to me; i.e. £5 for each year. This is *Simple Interest*.

2. Suppose I put £100 in the *Post Office Savings Bank* paying 2½%/. No interest will be sent to me, but if I send in my Bank Book to the General Post Office at the end of the first year I shall find that they have added £2. 10s. to my account. Next year they will pay me 2½%/. on £102. 10s. (£100 + £2. 10s.). And this goes on indefinitely. This is *Compound Interest*.

In one case the interest is paid every year (or at certain arranged periods). In the other the interest is not paid but is added on to the Principal each year, till I draw the whole amount.

National Savings Certificates also increase in value from year to year, but the rate per cent. of interest is not uniform.

The present price of a single Certificate is 16s., and this increases in the following way:

| | |
|---|----------|
| Value for 1 year | 16s. 0d. |
| Value after 13 months | 16s. 1d. |
| „ 14 „ | 16s. 2d. |
| (increasing at 1d. per month after the first year). | |
| Value after 60 months | 20s. 0d. |

The rate per cent. is therefore 1d. per month per 16s. *after the first year*, or 1s. for 16s. for 1 year;

i.e. £6¼ for £100 for 1 year;

i.e. at the rate of 6¼%/. *for the years in which interest is paid.*

The rate for the whole time is:

4s. for 16s. in 5 years,
£25 for £100 in 5 years,
£5 for £100 in 1 year.

Hence the value of the interest over the whole period of 5 years is at the rate of 5%.

But this is neither Simple nor Compound Interest as far as the whole period is concerned, for the interest goes on at 1*d.* per Certificate per month for a further period.

58. To find Compound Interest.

Ex. 1. *Method 1.*

Find the Compound Interest on £1250 for 3 years at 5%.

| | | |
|---|---|-------------------------|
| Principal at commencement | = | £1250 |
| Int. for 1st year = $\frac{5}{100} \times 1250$ | = | £62. 10s. |
| Principal for 2nd year | = | £1312. 10s. |
| Int. for 2nd year = $\frac{5}{100} \times £1312. 10s.$ | = | £65. 12s. 6 <i>d.</i> |
| Principal for 3rd year | = | £1378. 2s. 6 <i>d.</i> |
| Int. for 3rd year = $\frac{5}{100} \times £1378. 2s. 6d.$ | = | £68. 18s. 1½ <i>d.</i> |
| Amount at end of 3 years | = | £1447. 0s. 7½ <i>d.</i> |
| Principal at commencement | = | £1250 |
| Comp. Int. | = | £197. 0s. 7½ <i>d.</i> |

Ex. 2. *Method 2.*

Find the Compound Interest on £525. 12s. 9*d.* for 3 years at 4%.

$$£525. 12s. 9d. = £525. 12.75s. = £525.6375.$$

Keep to 5 places so as to ensure that 3 are correct in the answer, and mark off the last two columns by a line.

| | | | |
|-----|-------------------------|----|--------------------------|
| | 525.637 | 50 | |
| (2) | 21.025 | 50 | 4% 1st year |
| | 546.663 | 00 | |
| (3) | 21.866 | 52 | 4% 2nd year |
| | 568.529 | 52 | |
| (4) | 22.741 | 18 | 4% 3rd year |
| | 591.270 | 70 | Amount at end of 3 years |
| | 525.637 | 50 | |
| | 65.633 | 20 | Compound Interest |
| | = £65. 12s. 8 <i>d.</i> | | |

Note that in order to obtain lines (2), (3) and (4) we divide the Principal by 100 and multiply by 4. In other words, we start multiplying at the figure immediately to the left of the vertical line, using the carrying figure from the column to the right of

the vertical line. But we place our first result in the right-hand column.

Ex. 3. Find the Compound Interest on £750 for $1\frac{1}{2}$ years at $4\frac{3}{4}\%$.

| | | |
|---------|----|---|
| 750·000 | 00 | |
| 30·000 | 00 | 4% 1st year |
| 3·750 | 00 | $\frac{1}{2}\%$ 1st year ($4\% \div 8$) |
| 1·875 | 00 | $\frac{1}{4}\%$ 1st year ($\frac{1}{2}\% \div 2$) |
| <hr/> | | |
| 785·625 | 00 | |
| 15·712 | 50 | 2% $\frac{1}{2}$ year |
| 1·964 | 06 | $\frac{1}{4}\%$ „ ($2\% \div 8$) |
| ·982 | 03 | $\frac{1}{8}\%$ „ ($\frac{1}{4}\% \div 2$) |
| <hr/> | | |
| 804·283 | 59 | |
| 750 | | |
| <hr/> | | |

£54·284 = £54. 5s. 8d. to the nearest penny.

EXERCISE 24.

Find the Compound Interest and the Amount at the end of the periods quoted in the following. Give each answer to the nearest penny.

| | Principal | Time | Rate |
|-----|-----------------|----------------------|------------------|
| 1. | £400 | 3 years | 5% |
| 2. | £1000 | 4 years | 5% |
| 3. | £5 | 2 years | 1% |
| 4. | £525 | 3 years | 4% |
| 5. | £1750 | 2 years | 3% |
| 6. | £75. 15s. | 3 years | 4% |
| 7. | £325. 10s. | 2 years | 4% |
| 8. | £729. 17s. 6d. | 3 years | $2\frac{1}{2}\%$ |
| 9. | £1789. 13s. 8d. | 4 years | 5% |
| 10. | £7350. 16s. 6d. | 2 years | $5\frac{1}{2}\%$ |
| 11. | £5168. 14s. 7d. | $2\frac{1}{2}$ years | 3% |
| 12. | £8285. 12s. 9d. | $3\frac{1}{4}$ years | 4% |
| 13. | £5897. 15s. 6d. | 2 years 8 months | $4\frac{1}{2}\%$ |
| 14. | £7985. 10s. 3d. | 2 years 4 months | $2\frac{1}{2}\%$ |
| 15. | £1587. 15s. 2d. | 2 years 9 months | $5\frac{1}{2}\%$ |

the vertical line. But we place our first result in the right-hand column.

Ex. 3. Find the Compound Interest on £750 for $1\frac{1}{2}$ years at $4\frac{3}{4}\%$.

| | | |
|---------|----|---|
| 750·000 | 00 | |
| 30·000 | 00 | 4% 1st year |
| 3·750 | 00 | $\frac{1}{2}\%$ 1st year ($4\% \div 8$) |
| 1·875 | 00 | $\frac{1}{4}\%$ 1st year ($\frac{1}{2}\% \div 2$) |
| <hr/> | | |
| 785·625 | 00 | |
| 15·712 | 50 | 2% $\frac{1}{2}$ year |
| 1·964 | 06 | $\frac{1}{4}\%$ „ ($2\% \div 8$) |
| ·982 | 03 | $\frac{1}{8}\%$ „ ($\frac{1}{4}\% \div 2$) |
| <hr/> | | |
| 804·283 | 59 | |
| 750 | | |
| <hr/> | | |

£54·284 = £54. 5s. 8d. to the nearest penny.

EXERCISE 24.

Find the Compound Interest and the Amount at the end of the periods quoted in the following. Give each answer to the nearest penny.

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|-----|-----------------|----------------------|------------------|
| 1. | £400 | 3 years | 5% |
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| 3. | £5 | 2 years | 1% |
| 4. | £525 | 3 years | 4% |
| 5. | £1750 | 2 years | 3% |
| 6. | £75. 15s. | 3 years | 4% |
| 7. | £325. 10s. | 2 years | 4% |
| 8. | £729. 17s. 6d. | 3 years | $2\frac{1}{2}\%$ |
| 9. | £1789. 13s. 8d. | 4 years | 5% |
| 10. | £7350. 16s. 6d. | 2 years | $5\frac{1}{2}\%$ |
| 11. | £5168. 14s. 7d. | $2\frac{1}{2}$ years | 3% |
| 12. | £8285. 12s. 9d. | $3\frac{1}{4}$ years | 4% |
| 13. | £5897. 15s. 6d. | 2 years 8 months | $4\frac{1}{2}\%$ |
| 14. | £7985. 10s. 3d. | 2 years 4 months | $2\frac{1}{2}\%$ |
| 15. | £1587. 15s. 2d. | 2 years 9 months | $5\frac{1}{2}\%$ |

SECTIONAL REVISION C

EXERCISE 25 (a). MENTAL.

1. £119. 15s. 7½d. + £29. 13s. 10½d. + £156. 12s. 2d. + 9s. 7½d.
2. $\frac{2}{3} + \frac{5}{6}$.
3. $1\frac{1}{2}$ of $2\frac{2}{3}$.
4. Find the cost of $\frac{1}{4}$ cwt. of tea at 1s. 11d. per lb.
5. Bring £16·85 to £ s. d.
6. What is the Simple Interest on £250 for 4 years at 2 %?
7. What are the rates at 2s. 6d. in the £ on a house of £32 rateable value?
8. If 4 tons 8 cwt. of a certain material costs £72, what would be the cost of 6 tons 12 cwt. at the same rate?
9. Find x if $\frac{15}{72} = \frac{x}{8}$.
10. Bring 2 lb. 8 oz. to the fraction of 3 lb. 2 oz., in lowest terms.
11. Find the cost of $7\frac{1}{8}$ yards at 2s. 8d. per yard.
12. Give the sum of $\frac{2}{3}$ and $\frac{1}{2}$ as a decimal.
13. What is the cost of 7 score articles at 2s. 6d. each?
14. A sample of brass (copper and tin) contains 60 % of copper. How much tin is there in 112 lb. of brass?
15. The cost price of an article is £28. What is the selling price in order to gain 25 %?
16. Find the H.C.F. of 50, 75, 100.
17. $9\cdot3 \div 31$.
18. $96 \times \cdot625$.
19. $9125 \div 25$.
20. 340×102 .

EXERCISE 25 (b).

1. $\frac{25\cdot036 - 7\cdot9456}{\cdot025}$.
2. $\frac{6\frac{2}{3} - 1\frac{1}{2} \times 3\frac{1}{4}}{2\frac{1}{7}}$.
3. Find the value of £2·69375.
4. Bring 7s. 7½d. to the decimal of £1.
5. Find the cost of 2 tons 14 cwt. 3 qr. at £1. 19s. 10d. a ton, giving the answer to the nearest shilling.

6. Find the Simple Interest to the nearest penny on £570. 18s. 6d. for 4 years 9 months at 4%.

7. If $\frac{5}{8}$ of a quarter of wheat cost 81 shillings, what will be the cost of $\frac{15}{8}$ of a bushel?

8. Find the sum of 2.35 of 2s. 1d. and 0.03 of £6. 3s. 9d.

9. At what price must I sell a bicycle costing £14. 10s., in order to make a profit of 15%?

10. A bankrupt has £229. 7s. and can only pay 5s. 6d. in the £. How much does he owe altogether?

EXERCISE 25 (c).

1. A man cycled the following numbers of miles in six days: 21, 6, 14, 10, 38 and 19. How many miles did he cycle on the seventh day if his average number of miles a day for the seven days was 19 miles?

2. A contractor engages to clear a site in 5 days. He employs 12 carts and at the end of 3 days only half the work is done. How many more carts must he employ in order to finish the work in the specified time?

3. Find the total payment for the following, if 5% discount is deducted for cash:

4 dozen collars at 11½d. each.

6 felt hats at 15s. 6d. each.

20 ties at 28s. a dozen.

30 pairs of socks at 33s. a dozen pairs.

25 pairs of suspenders at 1s. 4d. a pair.

47 pairs of laces at 6s. a dozen pairs.

½ gross of assorted studs at 1s. 3d. a dozen.

4. A train travels at the rate of 20 metres a second. Find its speed in miles per hour to the nearest mile, if 1 metre is taken as 39.37 in.

5. A block of metal alloy weighs 4 cwt. 3 qr. 18 lb., and is composed of 94% copper and the rest tin. How many lbs. of tin does it contain?

6. A grocer buys 7 cwt. of sugar at £28 per ton. He sells 336 lb. at 3½d. per lb. The price then falls, and he has to sell the remainder at a reduction of 4s. 8d. per cwt. Find his total gain or loss per cent. on cost price for the whole transaction.

7. If $\frac{1}{4}$ of a cornfield is cut by 5 men in 4 days, how many men would be required to cut the remainder of the field in 5 days?

8. Of three numbers the first is twice the second, and it is also thrice the third. The average of the three numbers is 44. Find the numbers.

9. If the interest on £150 for 7 months is £3. 5s. $7\frac{1}{2}d.$, what should be the interest at the same rate on £66. 13s. $4d.$ for 15 months?

10. A house was sold for £1782 at a loss of 4% . At what price should it have been sold so as to gain 4% ?

EXERCISE 26 (a). MENTAL.

1. $379 + 18,694 + 25,136 + 1897 + 83.$

2. $35 \cdot 1026 - 29 \cdot 349.$ 3. $512 \times \cdot 025.$

4. $\pounds 5000 - \pounds 2908. 17s. 9\frac{1}{2}d.$

5. $3\frac{5}{8}$ of £27. 6. $3\frac{2}{3} - 1\frac{1}{4}.$

7. Find the L.C.M. of 6, 9, 10, 15.

8. 9 gallons of milk cost 15s. What is the price per pint?

9. What is the value of $16\frac{2}{3}\%$ of £96?

10. Find the Simple Interest on £425 for 4 years at $2\frac{1}{2}\%$.

Find the cost of:

11. 100 articles at $11\frac{3}{4}d.$ each.

12. 3 dozen articles at $2\frac{1}{2}d.$ each.

13. 45 chairs at 19s. $10d.$ each.

14. 2 tons 15 cwt. at £5 per ton.

15. 52 weeks' wages at £1. 15s. per week.

16. Express 45 as a percentage of 600.

17. If 3 Hectometres of cloth cost 1650 francs, what is the cost of a metre?

18. Bring 2.45 of £6 to £ s. d.

19. An article bought for $1\frac{1}{4}d.$ is sold for $1\frac{1}{2}d.$ What is the gain per cent.?

20. How many $7\frac{1}{2}d.$ books can be bought for £1. 1s. $3d.$?

EXERCISE 26 (b).

$$1. \frac{3\frac{1}{2} - 1\frac{5}{8} \div 2\frac{3}{4}}{2\frac{2}{3} + 4 \times 3\frac{1}{8}}.$$

$$2. \frac{2.05 \times .026}{3.573 - 3.55168}.$$

3. If $17\frac{1}{2}$ cwt. of coal cost £2. 2s. $3\frac{1}{2}d.$, what weight can be purchased for £2. 15s. $7d.$?

4. What is the yearly interest to the nearest penny on £217 at $4\frac{1}{4}\%$ per annum?

5. Find the value of 437,480 lb. of rubber at the price of 1s. $8\frac{3}{4}d.$ per lb.

6. If a litre = 1.76 pints, express 36 gallons in litres to the nearest litre.

7. From 20 yards of wire, how many pieces, each $7\frac{7}{8}$ in. long, can be cut, and what is the length of the piece left over?

8. If 8 men can build a house in 312 days, how many men will do it in 32 days?

9. Find the Compound Interest on £4512 for 3 years at 4% .

10. What Income Tax must be paid on an income of £595 at the rate of 3s. $6d.$ in the £ if £225 is exempt from tax?

EXERCISE 26 (c).

1. A Kilogram is 2.2 lb. and a pint of water 20 ounces. Find the weight of a quarter of a pint of water in grams, to the nearest gram.

2. A new locomotive, on a trial run, went part of the way at a speed of 81 miles per hour. Find, to the nearest tenth of a second, how long it would take, at that speed, to do $1\frac{1}{4}$ miles.

3. A man leaves one-third of his property to his wife, one-fourth of the remainder to each of his three children, and what is then left to be equally divided between two nephews, and each nephew gets £740. What is the total value of the property?

4. In an examination 9 candidates received 97 marks each, 25 received 79 each, 33 received 57 each, and 69 received 40 each. Find the average marks of the whole number examined.

5. A man borrowed £150 from a money-lender and agreed to pay him £2. 7s. $6d.$ interest per month. At what rate per cent. per annum was he borrowing?

6. An agent receives £38. 13s. 4d. commission on selling £580 worth of goods. What value of goods must he sell to earn £50 commission?

7. In April, 1921, the population of Blackburn was 129,400. During the next twelve months the birth rate was 19·5 per thousand of the population, and the death rate 12·7 per thousand. Estimate, approximately, the population in April, 1922.

8. Find the gain per cent. in buying articles at 5 for 4d. and selling them at 4 for 5d.

9. Goods are sold for £12. 9s. 4½d., this being a loss of 5 % . What should the selling price have been to have gained 14 % ?

10. Divide £7. 12s. 9d. between *A* and *B* so that three-quarters of *A*'s share will equal five-ninths of *B*'s share.

EXERCISE 27 (a). MENTAL.

1. $287 + 513 + 9 + 26 + 538 + 79$.

2. £291,562. 10s. 8d. — £189,346. 12s. 6½d.

3. From 15 days 12 hr. 20 min. take 6 days 21 hr. 50 min.

4. I leave home at 8.47 a.m., and reach my destination at 9.58 a.m. How many minutes have I taken?

5. Express 17s. 8d. as the decimal of £1 to the nearest third place of decimals.

6. Find the value of 12 % of £20.

7. What percentage of 96 is 72?

8. An article bought for £2. 10s. is sold for £2. 12s. 6d. What is the gain per cent.?

9. What is the selling price of an article costing 3s. 4d., if there is a loss of 15 % in selling?

10. 0·8 of 5·6.

11. $119 \div 1·7$.

12. 763×25 .

13. 0·625 of £12.

14. $4\frac{3}{8} \div \frac{7}{16}$.

15. $1\frac{1}{2} + 2·3$.

Find the cost of:

16. 7 dozen articles at $2\frac{3}{4}d.$ each.
17. 3 score articles at $5s. 9d.$ each.
18. 30 articles at $1s. 6d.$ each.
19. 3 lb. 10 oz. at $1s. 4d.$ per lb.
20. 2 tons 18 cwt. at £2 per ton.

EXERCISE 27 (b).

1. $\frac{1}{2} \times (\frac{1}{3} + \frac{1}{4}) \div 2\frac{3}{8}.$
2. $4.3875 \times 86.4.$
3. Find the value, to the nearest penny, of 478 gallons of oil at 4.16 shillings per gallon.
4. Find to the nearest penny the Simple Interest on £119. 5s. 6d. for $2\frac{1}{2}$ years at $5\frac{1}{2}\%$ per annum.
5. Divide 3946.84 by $.056$ correct to two decimal places.
6. If 84 articles cost £9. 5s. 6d., what will 176 cost?
7. Find the cost of 510.9 yards of material at $7s. 2d.$ per yard.
8. If 5 men can earn £19. 2s. 6d. by working 9 days, how many men will earn £43. 7s. if they only work for 6 days?
9. Find the value of a dollar in francs and centimes to the nearest centime when £4 was equivalent to 101 francs and £100 to 487 dollars.
10. What annual income is obtained by investing £1875 in a concern which pays a dividend of $3\frac{1}{2}\%$ every half year?

EXERCISE 27 (c).

1. A father deposited £425 in a Building Society for his son. At the end of 18 years the son drew out the accumulated amount of £769. 5s. What average rate of interest per cent. per annum was paid?
2. 7680 books were distributed among four towns in proportion to the population. The populations were respectively 4500, 6750, 11,250 and 13,500. How many books did each town receive?

3. A bankrupt, after payment of preferential claims and legal expenses, had £1734. 11s. 8d. left, which enabled him to pay 9s. 7d. in the £ to the ordinary creditors. Find how much he owed them.

4. The cost of running 8 machines for 15 days is £38. What will it cost to run 18 similar machines for 12 days?

5. A man's savings were invested thus: £560 in a Building Society paying $4\frac{1}{2}\%$ per annum; £620 lent to a Corporation at 4% per annum; £200 in the Post Office Savings Bank at $2\frac{1}{2}\%$ per annum. Show that on the whole of his savings he was receiving about 4% per annum interest.

6. What is the gain per cent. obtained by purchasing at £1 per cwt. and selling at the rate of 3·2d. per lb.?

7. Envelopes bought at £1 per thousand are sold at $3\frac{1}{2}d.$ per packet of a dozen. How many packets have been sold when a profit of £1. 5s. 10d. has been made?

8. A man places £450 on deposit receipt on 27th January, 1921, and withdraws it on the 3rd September of the same year. If the rate of interest during the period is $3\frac{1}{2}\%$ per annum, what amount does he receive on the 3rd September?

9. A man holds 550 five-shilling shares in a Company which declares a half-yearly dividend at the rate of 7% per annum. What dividend should he receive after Income Tax at 4s. in the £ has been deducted?

10. By how much does the Compound Interest on £250. 10s. 6d. for 2 years at $5\frac{1}{2}\%$ exceed the Simple Interest for the same time at the same rate?

EXERCISE 28 (a). MENTAL.

1. $24\cdot13 + 392\cdot68 + 1\cdot953 + 18\cdot6427 + 9\cdot6.$
2. $1234 \times 25.$
3. $586,750 \div 25.$
4. 0·68 of 250.
5. $2\cdot828 \div \cdot07.$
6. £3124. 10s. $8\frac{1}{4}d.$ - £956. 19s. $10\frac{3}{4}d.$
7. Find the L.C.M. of 10, 12, 15.
8. $2\frac{2}{3} + 1\frac{1}{2}.$
9. $5 - 2\frac{2}{7}.$
10. $3\frac{1}{3} \div 2\frac{1}{2}.$
11. $1\frac{1}{5}$ of 75.

12. How many $2\frac{1}{2}d.$ pencils can be bought for 30s.?
13. What is the cost of 8 Hectograms at 25 fr. per Kilogram?
14. Find the Simple Interest on £120 for 4 years at $3\frac{1}{2}\%$.
15. Find 15% of 5 shillings.
16. Express 88 yards as the decimal of a mile.

Find the cost of:

17. A quarter of a cwt. of tea at 2s. 6d. per lb.
18. 60 eggs at 8 for a shilling.
19. 540 articles at 3d. per dozen.
20. 13 scarves at 8s. 6d. each.

EXERCISE 28 (b).

$$1. \frac{\frac{1}{3}}{\frac{1}{24}} \div \frac{\frac{1}{4} + \frac{1}{8} + \frac{1}{6}}{\frac{1}{8} + \frac{1}{9} + \frac{1}{10}}. \qquad 2. \frac{5.625}{1.375} - \frac{7}{22}.$$

3. What decimal of 1 ton (correct to 3 places of decimals) is 17 cwt. 2 qr. 15 lb.?

4. Multiply 16.408 by 40.84 and then write down the answers to

- (a) 164.08×4084 ,
- (b) $.16408 \times .4084$,
- (c) $.0016408 \times 40840$.

5. Find the cost of 2 tons 17 cwt. 3 qr. at 22s. 6d. per cwt.

6. 486 articles cost £39. 9s. 9d. What will 100 cost at the same rate?

7. What profit per lb. will be made by selling at 8 lb. for 2s. 6½d. goods which cost £1. 10s. 11d. per cwt.?

8. A man sells goods for £137. 0s. 6d., and gains 8%. How much profit does he make?

9. On what sum is the Simple Interest for 2 years 6 months at 4% equal to £156. 17s. 9d.?

10. A man invests £55,000 in a concern which gives a return of £3. 10s. for every £110 invested. What income will he receive in 5 years?

EXERCISE 28 (c).

1. A tradesman expended fourteen guineas in the purchase of gloves at 3s. 6d. per pair. Thirteen pairs, becoming shop-soiled, were sold at a reduced price, while the others were retailed at 4s. 11d. per pair. The total profit was £4. 10s. 10d. At what price per pair were the shop-soiled gloves sold?

2. A man's income is £297. 10s. per annum. If he spends $\frac{1}{4}$ of this during the year, and contributes £19. 11s. to charities, what fraction of his income does he save?

3. In a factory 43 men are each earning £2. 17s. 6d. weekly, 12 men are each earning £3. 4s. 6d., and 6 men are each earning £4. 18s. 6d. Find the average weekly wage per man, to the nearest shilling.

4. A man makes a journey of 72 miles. He does 39 miles by train and the rest by motor at 18 miles per hour. The whole journey takes 2 hours 42 minutes. Find the speed of the train in miles per hour.

5. The cost of publishing a book is as follows: £100 for paper, £275 for printing, 9d. a copy for binding, etc. If an edition of ten thousand copies is printed, at what price must each copy be sold to make a profit of 25 %?

6. A man's rent is £36 per annum, and his rates are 0.9 of his rent. In rent and rates together he pays 0.15 of his annual income. What is his annual income?

7. A consignment of eggs was bought at 4s. 3d. per doz. Half were sold at 6s. per doz., and half at 5s. 9d. per doz. Find the gain per cent.

8. A man living in Great Britain holds 225 shares in an Indian Tea Garden which declares a dividend of $7\frac{1}{2}$ rupees per share. What amount, to the nearest penny, should he receive when the value of the rupee is 1s. $6\frac{1}{4}$ d.?

9. A gallon of water weighs 10 lb., and 1 lb. equals 454 grammes. What will be the weight in Kilograms of 3 gallons 3 quarts of water?

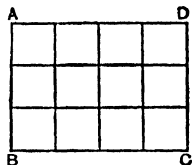
10. Find the premium paid to insure goods worth £292. 10s. 0d., to cover both their value and the premium at $2\frac{1}{2}$ %.

MENSURATION

AREAS OF RECTANGLES

59. Suppose the rectangle $ABCD$ has one side AD 4 units in length, and another side AB 3 units.

We can divide the rectangle as shown into 12 squares each of which has a side of 1 unit. There are twelve such squares; hence the area of $ABCD$ is 12 square units.



Generally, if the sides are a units and b units in length, the area is ab square units. Or if we call the base b and the height h , the area is base \times height, or bh .

$$A \text{ (area of rectangle)} = bh.$$

Note. In finding the area of a rectangle, we must reduce both sides to the same *unit*, inches, feet, yards, etc., before multiplying the units together; e.g. if one side is 2 yards and the other 2 feet, the area is not 4 *square units*, whether square feet or square yards, but 6×2 square feet.

60. Ex. 1. Find the area of a rectangle with sides 3 yd. 2 ft. 1 in. and 2 yd. 1 ft. 11 in.

Reduce both sides to inches:

$$3 \text{ yd. } 2 \text{ ft. } 1 \text{ in.} = 133 \text{ in.}$$

$$2 \text{ yd. } 1 \text{ ft. } 11 \text{ in.} = 95 \text{ in.}$$

$$\text{Area} = 133 \times 95 \text{ sq. in.}$$

$$= 12,635 \text{ sq. in.}$$

$$= 87 \text{ sq. ft. } 107 \text{ sq. in.}$$

$$= 9 \text{ sq. yd. } 6 \text{ sq. ft. } 107 \text{ sq. in.}$$

Ex. 2. The area of a rectangle is $5\frac{1}{2}$ sq. yd. and one side is 2 ft. 6 in. Find the other side.

$$A = bh.$$

$$\therefore h = \frac{A}{b} = \frac{5\frac{1}{2} \text{ sq. yd.}}{2\frac{1}{2} \text{ ft.}}$$

$$= \frac{49\frac{1}{2} \text{ sq. ft.}}{2\frac{1}{2} \text{ ft.}}$$

$$= \frac{99}{2} \times \frac{2}{5} \text{ ft.}$$

$$= 19\frac{4}{5} \text{ ft.}$$

$$= 2 \text{ sq. yd. } 1 \text{ sq. ft. } 115\frac{1}{5} \text{ sq. in.}$$

Ex. 3. Find the cost of covering a wall 14 ft. 6 in. long and 10 ft. high with paper costing 1s. 3d. per sq. yd.

$$\text{Area} = 14\frac{1}{2} \times 10 \text{ sq. ft.}$$

$$= \frac{14\frac{1}{2} \times 10}{9} \text{ sq. yd.}$$

$$\text{Cost} = \frac{14\frac{1}{2} \times 10}{9} \times 1\frac{1}{4} \text{ shillings}$$

$$= £\frac{29}{2} \times \frac{rg}{9} \times \frac{5}{4} \times \frac{1}{\frac{rg}{2}}$$

$$= £14\frac{5}{4} = £1. 0s. 1\frac{2}{3}d.$$

or £1. 0s. 2d. to the nearest penny.

Ex. 4. What will be the cost of covering a space 3 yd. 2 ft. long and 2 yd. 1 ft. wide with tiles measuring 8 in. by 7 in., at 1s. 9d. per dozen?

$$\text{Space covered} = 11 \times 7 \text{ sq. ft.}$$

$$= 11 \times 7 \times 144 \text{ sq. in.}$$

$$\text{Area of one tile} = 8 \times 7 \text{ sq. in.}$$

$$\text{No. of tiles} = \frac{11 \times 7 \times 144}{8 \times 7}.$$

$$\text{No. of dozen tiles} = \frac{11 \times 7 \times 144}{8 \times 7 \times 12}.$$

$$\text{Cost in shillings} = \frac{11 \times 7 \times \overset{rg}{144}}{8 \times \cancel{7} \times \cancel{12}} \times \frac{\cancel{rg}}{\cancel{4}}$$

$$= 281 \text{ shillings}$$

$$= £1. 8s. 10\frac{1}{2}d.$$

Note. *Mensuration means measurement, and it is simply the application of ordinary Arithmetic to problems of measurement of great importance in daily life, e.g.*

Carpeting and papering rooms.

The measurement of fields and hay stacks.

Finding the capacity of tanks, barrels, etc.

Mensuration problems are no more difficult than other problems, and some of the reasons why many students are unsuccessful in such sums are:

1. *The underlying principles and formulae are not known.*
2. *No diagrams are drawn.*
3. *The statements are not set out in a systematic manner.*

EXERCISE 29 (a). MENTAL.

Find the areas of the rectangles having the following pairs of sides:

1. 10 in.; 8 in. 2. 8 in.; $4\frac{1}{2}$ in. 3. 4 ft.; 3 ft. 6 in.
4. 5 ft.; 4 ft. 3 in. (sq. ft.). 5. 1 ft. 3 in.; 1 ft. (sq. in.).
6. 3 ft. 8 in.; 3 ft. 7. 1 ft. 6 in.; 4 yd. (sq. yd.).
8. 25 cm.; 40 cm. 9. 2 m. 12 cm. 5 mm.; 8 m.
10. 3·25 m.; 400 cm. (sq. metres).

Find the other side of each of the rectangles in Questions 11—15:

11. Area 40 sq. ft.; length 6 ft.
12. Area 515 sq. in.; length $51\frac{1}{2}$ in.
13. Area 3 sq. ft., 72 sq. in.; breadth 1 ft. (length in feet and inches).
14. Area $5\frac{1}{3}$ sq. yd.; length 2 ft. 8 in. (breadth in yards).
15. Area 525 sq. metres; one side 10·5 metres.
16. Give the number of square yards in (a) 1 acre, (b) $\frac{1}{4}$ acre, (c) $\frac{1}{11}$ acre.
17. How many square inches are there in (a) $\frac{1}{4}$ sq. ft., (b) $1\frac{1}{4}$ sq. ft., (c) 100 sq. ft.?
18. What is the area of a square plot of 22 yards' side?
19. Find the cost of covering a space 7 ft. by 3 ft. at 3s. 9d. per sq. yd.
20. How many square metres are there in an oblong 150 cm. by 120 cm.?
21. Find the area in square feet of a carpet $3\frac{1}{2}$ yd. square.
22. The area of a square room is 1849 sq. ft. What is the length of a side?
23. A rectangle 8 ft. long by 4 ft. 6 in. broad is divided into two parts by a diagonal. What is the area of one of the triangles?
24. What is the cost of painting a wall 14 ft. long by 10 ft. wide at 3d. a sq. ft.?
25. Give the length of a rectangle if the area is 363 sq. ft. and one side is three times the other.

EXERCISE 29 (*b*).

Find the areas of the rectangles having the following pairs of sides:

1. 28 ft.; 18 yd. Area in sq. yd.
2. 1 yd. 1 ft. 6 in.; 1 yd. 9 in. Area in sq. yd., sq. ft., and sq. in.
3. 37 ft. 8 in.; 25 ft. 3 in. Area in sq. ft. and a fraction.
4. 1·375 yd.; ·825 ft. Area in sq. ft. and a decimal.
5. 2156 yd.; 1865 yd. Area in acres and sq. yd.
6. 15·65 cm.; 5·78 mm. Area in sq. cm., to the nearest sq. cm.
7. 8558 yd.; 2926 yd. Area in sq. miles and acres to the nearest acre.
8. 560 metres; 1254 cm. Area in sq. metres.

Find the other side of each of the rectangles in Questions 9—12:

9. Area 61·125 sq. ft.; one side 7·5 ft.
10. Area $315\frac{3}{8}$ sq. yd.; one side $32\frac{5}{8}$ ft.
11. Area $1\frac{3}{4}$ acres; one side 363 yd.
12. Area 2375 sq. metres; one side 211·5 metres. Give answer to the nearest centimetre.

Find the cost of covering the following areas:

13. 25 ft. by 16 ft. at 3s. 9d. a sq. ft.
14. 15 ft. by 8 ft. at £1. 7s. 6d. a sq. yd.
15. 4 yd. 2 ft. 6 in. by 2 yd. 1 ft. 8 in. at 3d. a sq. in.
16. 15·375 ft. by 10·125 ft. at 4s. a sq. ft.
17. $3\frac{5}{8}$ yd. by $1\frac{3}{4}$ yd. at £1. 5s. 8d. a sq. yd.
18. 3 m. 15 cm. by 2 m. 75 cm. at 12s. a sq. metre.
19. $1\frac{1}{2}$ miles by 36 ft. at £1. 7s. 6d. a sq. yd.
20. 60 ft. 9 in. by 15 in. at 7s. 6d. a sq. ft.

EXERCISE 29 (c).

1. A piece of perforated sheet zinc 3 ft. $8\frac{1}{2}$ in. long by 3 ft. broad cost 6s. 6d. What must be the price per sq. ft.?

2. How many rectangular tiles 9 in. by 6 in. are required to pave a passage 6 ft. by 22 ft.? The tiles cost 3d. each, and the total cost of paving was £6. 18s. 0d. How much was charged for labour?

3. An oblong field is $\frac{1}{4}$ mile long and $\frac{1}{8}$ mile wide. Find its rent at £2. 10s. per acre.

4. The total rental of 656 acres of land was £820. What rent should be paid for 60 oblong plots cut from it, each measuring 55 yd. by 44 yd.?

5. The area of an oblong field is 22·875 acres. Its length is 16·5 chains. Find its breadth.

6. How many cards, each 3 in. by $1\frac{1}{2}$ in., can be cut from 100 sheets of board, each sheet measuring 2 ft. 3 in. by 1 ft. 9 in.? What will the boards cost at 1s. 6d. per 100?

7. A piece of ground having an area of 1 rood 25 sq. pole has built on it a house of 50 ft. frontage and 75 ft. depth. The rest is laid out as a garden. By how many square yards does the garden space fall short of $\frac{1}{2}$ acre?

8. Find the cost of covering a lawn 25 yd. by 16 yd. 2 ft. with turfs each 30 in. by 12 in. at 24s. per 100.

9. If the size of an examination paper is 28·2 cm. by 22 cm., how many square metres of paper are required in printing 750 copies?

10. What will be the cost of glazing the ten windows of a house, each window having 8 panes of glass, and each pane measuring 35 cm. by 30 cm.; the cost per square decimetre being 3 francs 50 centimes?

11. Find the cost (to the nearest franc) of the carpet for a room 10·64 metres long and 7·25 metres wide, at 2 francs 80 centimes per square metre.

12. Find, to the nearest centimetre, the length of the side of a square which has an area of 12 square metres.

13. A room is 18 ft. 9 in. long and 15 ft. 6 in. wide, and a carpet for the room costs $7\frac{1}{2}$ guineas. If the carpet cost 6s. 8d. per square yard, find the number of square feet which are left uncovered by the carpet.

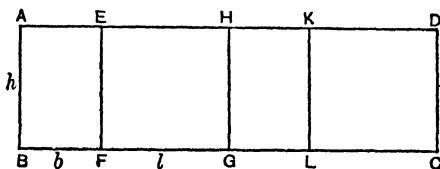
14. A courtyard 42 ft. long and 36 ft. wide is paved with square tiles each measuring 8 in. to the side. How many tiles will be required?

15. An allotment has an area of 1 sq. chain. If it is 36 ft. wide, find its length in chains.

16. What will be the cost of paving a passage $4\frac{1}{2}$ ft. wide and 11 ft. long with tiles measuring 3 in. by $5\frac{1}{2}$ in. at 4s. 9d. a dozen?

MISCELLANEOUS PROBLEMS ON RECTANGULAR AREAS

61. Areas of walls, ceilings and floors of a room.



(1) Imagine the walls of a room placed so as to form one surface as indicated by $ABCD$.

(a) $ABFE$ and $HGLK$ are the "short" walls.

(b) $EFGH$ and $KLCD$ are the "long" walls.

If therefore the length is called l , the breadth b , and the height h , the areas of the walls are:

(a) bh and bh . Total $2bh$.

(b) lh and lh . Total $2lh$.

Total areas of the four walls $= 2lh + 2bh$

$$= 2h(l + b).$$

Learn:

The total area of the four walls of a room is found by multiplying the sum of the length and breadth by twice the height.

(2) The areas of floor and ceiling are found by multiplying length by breadth.

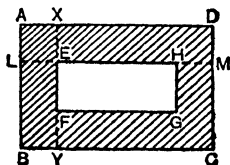
(3) Usually the areas of windows, doors and fire-places have to be subtracted from the total area of the walls, in order to find the amount of wall surface to be papered, coloured, etc.

62. Areas of borders, etc.

Two types of problems of which this is a diagram are the following:

(1) To find the area of the inner rectangle, given the external dimensions and the widths of the borders.

(2) To find the area of the border.



In both cases it is necessary to remember that:

(a) EH is found by subtracting *both* LE and HM from AD .

(b) EF is found by subtracting *both* XE and FY from AB .

Often in these problems the border is of the same width all round, and it is in such problems that the error is usually made of subtracting the width of only one border.

The drawing of a diagram in each case will help in avoiding this error.

Ex. 1. A floor 16 ft. by 10 ft. is partly covered by a carpet, leaving a border 2 ft. wide all round it. Find

(a) the area of the carpet,

(b) the area of the border.

Using the above as a rough diagram, we get:

$$\text{External area} = 16 \times 10 \text{ sq. ft.}$$

$$= 160 \text{ sq. ft.}$$

$$\text{Internal area} = (16 - 4)(10 - 4) \text{ sq. ft.}$$

$$= 12 \times 6 \text{ sq. ft.}$$

$$= 72 \text{ sq. ft. (1).}$$

$$\text{Difference} = 160 - 72 \text{ sq. ft.}$$

$$= 88 \text{ sq. ft. (2).}$$

The first answer gives the area of the carpet, and the second the area of the border.

Ex. 2. Find the cost of a carpet 54 in. wide, required to cover a room 15 ft. long and 12 ft. wide, if the carpet is sold at 12s. 6d. per yd.

$$\text{Area of room} = 15 \times 12 \text{ sq. ft.}$$

$$= 20 \text{ sq. yd.}$$

$$\text{Area of a strip of carpet a yard long}$$

$$= \frac{54}{36} \text{ sq. yd.}$$

$$\text{Cost of one strip} = 12\frac{1}{2} \text{ shillings.}$$

$$\text{No. of strips} = 20 \div \frac{54}{36}.$$

$$\text{Cost} = 20 \div \frac{54}{36} \times 12\frac{1}{2} \text{ shillings}$$

$$= \frac{20 \times 12\frac{1}{2} \times 36}{54}$$

$$= \text{£}8. 6s. 8d.$$

EXERCISE 30 (a). MENTAL.

The following are the dimensions of rooms in which walls, ceilings and floors are all rectangular. Give the area of ceiling (or floor), long wall, and short wall in each:

| | Length | Breadth | Height |
|-----|--------------|--------------|-------------|
| 1. | 12 ft. | 10 ft. | 10 ft. |
| 2. | 16 ft. | 12 ft. | 10 ft. |
| 3. | 25 ft. | 12 ft. | 10 ft. |
| 4. | 25 ft. | 15 ft. | 9 ft. |
| 5. | 16 ft. 6 in. | 10 ft. | 10 ft. |
| 6. | 18 ft. | 12 ft. 4 in. | 8 ft. |
| 7. | 16 ft. | 10 ft. 3 in. | 9 ft. |
| 8. | 16 ft. | 12 ft. | 9 ft. 6 in. |
| 9. | 15 metres | 12 metres | 9 metres |
| 10. | 16 metres | 12.5 metres | 8 metres |

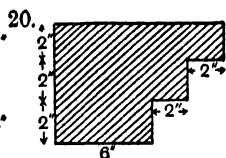
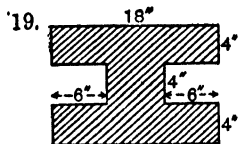
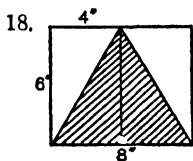
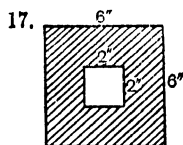
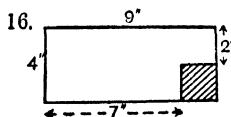
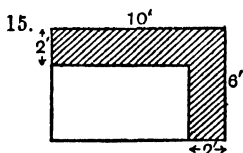
11. What is the total wall area of the room in Question 1?

12. The long wall in Question 3 has a door 7 ft. by 4 ft. What area remains to be papered?

13. In the room in Question 4 the long wall has a fire-place occupying a space 5 ft. by 4 ft. How much of that wall remains?

14. Which of the rooms in Questions 5 to 8 has the largest floor, and what is the cost of staining it at 2*d.* a sq. ft.?

Find the areas of the shaded portions in the following figures:



21. A rectangle with sides 8 in. by 6 in. has a square 16 sq. in. in area inscribed in it. What is the area of the space around the square?

22. A lawn 16 ft. by 10 ft. has a path 2 ft. wide all round it. What is the total area of lawn and path?

23. A garden consists of three plots 15 ft. by 8 ft., separated by two paths 2 ft. 6 in. wide and 8 ft. long. What is the total area of the garden?

24. What is the total area of the four walls of a room 20 ft. by 15 ft., and 12 ft. high?

25. What length of linoleum 1 yd. 1 ft. wide is required to cover the floor of a rectangular room 18 ft. by 16 ft.?

26. How many rectangular stones 3 ft. by $2\frac{1}{4}$ ft. are required to pave a square space of 3 yd. side?

27. How many strips of paper 12 yd. by 1 yd. are required to cover a wall 24 ft. by 9 ft.?

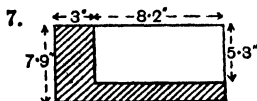
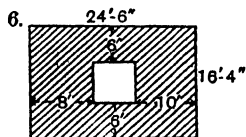
28. How many tiles 8 in. square are required to cover a floor 16 ft. long, 13 ft. 4 in. broad?

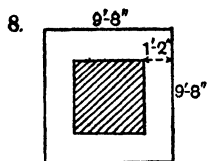
EXERCISE 30 (b).

Find the total wall surface of the following rooms:

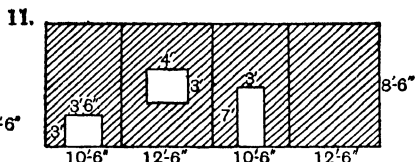
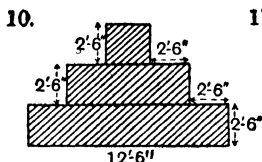
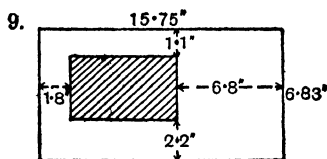
| | Length | Breadth | Height | Area |
|----|--------------|--------------|-------------|---------------------|
| 1. | 24 ft. | 16 ft. | 10 ft. | Square feet |
| 2. | 15 ft. 6 in. | 12 ft. 6 in. | 8 ft. 6 in. | Square feet |
| 3. | 24 ft. 9 in. | 12 ft. 3 in. | 9 ft. | Square yards |
| 4. | 18 ft. 2 in. | 12 ft. 9 in. | 8 ft. 3 in. | Sq. ft. and sq. in. |
| 5. | 19 ft. 5 in. | 16 ft. 4 in. | 8 ft. | Square feet |

Find the areas of the shaded portions in the following figures, which are not drawn to scale:





Regular



12. Find the cost of the carpet covering the floor in Question 1 at 15s. 6d. a sq. yd.

13. Find the cost of papering the four walls in Question 2 at 1s. 6d. a sq. yd., deducting 96 sq. ft. for door, window and fireplace.

14. In Question 8 a carpet is shown. Find the cost at 12s. 0d. a sq. yd.

15. What is the cost of paper for the walls in Question 11 at 2s. 9d. a piece, if the piece is 27 in. wide and 30 ft. long?

EXERCISE 30 (c).

1. How many yards of carpet 2 ft. 3 in. wide are required for a room 18 ft. long and $13\frac{1}{2}$ ft. broad?

2. The area of the walls of a room is 588 sq. ft. If the length is 14 ft. 6 in., and the breadth 13 ft. 6 in., find the height.

3. Find the cost of staining the border of a floor 16 ft. by 14 ft., at 4s. 6d. per sq. yd., if the border is 1 ft. wide?

4. A rectangular room having an area of 1875 square yards was three times as long as it was broad. What was its length?

5. What is the cost of carpeting a room 24 ft. by 27 ft. with carpet $\frac{2}{3}$ yd. wide at 3s. per yd.?

6. How many times must I run round a 10 acre field to run 5 miles?

7. A lawn 50 yd. square has a path 1 yd. wide along two sides. What is the area of the path?

8. On the floor of a room is a carpet 15 ft. 7 in. long and 10 ft. 10 in. broad, and there is an uncarpeted margin, 18 in. broad, all round. Find, in square feet, the area not carpeted.

9. On a map a field of 40 acres is represented by an area of $2\frac{1}{4}$ sq. in. How many inches, on the map, will there be between two places 5 furlongs apart?

10. A rectangular garden, 90 ft. long and 40 ft. wide, has flower beds 3 ft. wide along each of the longer and one of the shorter sides. It also contains a lawn measuring 80 ft. by 30 ft. What area remains for paths?

11. The dimensions of a map drawn to a scale on which an inch represents 440 yd. are 10·8 in. by 7·5 in. What area in square miles does it represent?

12. A rectangular plot 80 ft. long and 50 ft. wide has two paths each 5 ft. wide from the middle of each side to the middle of the opposite side. The rest of the plot is covered with turf. How many square feet of turf are used?

13. The floor of a corridor 6 ft. wide and 18 ft. long has a strip of boarding 2 ft. wide down the middle, and the remainder is filled up with tiles each of which is 4 in. by 9 in. How many tiles are there?

14. A room is 12 ft. long and 11 ft. broad. What will it cost to lay linoleum on the floor so as to leave everywhere a margin of one foot, the cost of the linoleum being 2s. 6d. per sq. yd.?

15. A rectangular plot of land 50 ft. long and 30 ft. broad is to be turned into a lawn surrounded by a gravel path 3 ft. wide. If the cost of laying down the gravel required is 6d. a sq. ft., and that of the turfing 3s. a sq. ft., find the total cost.

16. A picture 60 cm. by 42 cm. has an oak mount 14·5 cm. wide on longer sides and 18·5 cm. on other sides. This is surrounded by a frame 85 mm. wide. What is the total wall space covered by the picture? Express your answer in square metres.

17. A plot of ground is 80 ft. long and 40 ft. wide, and a path 4 ft. wide is cut along the two long sides and one of the short sides. What would be the cost of covering the path with stone at 4s. 6d. per sq. yd.?

18. A full-sized tennis court is 78 ft. by 36 ft. If it is desired to allow 10 extra feet at each end and 5 extra feet at each side, what would it cost to turf the extra ground with turfs 3 ft. by 1 ft. at 7s. 6d. per 100 turfs?

19. On a map, an area of $1\frac{1}{4}$ sq. in. represents a rectangular field of 8 acres, and one side of the field is represented by $2\frac{1}{2}$ in. What are the dimensions of the field and the scale of the map, i.e. inches to the mile?

20. The walls of a room 15 ft. long, 13 ft. 6 in. wide, and 10 ft. 6 in. high are painted at a cost of 19 guineas. If the roof is painted at an additional cost of £5. 1s. 3d., what is the cost per square foot (a) for the walls, (b) for the roof?

21. A rectangular lawn 85 ft. long and 45 ft. wide is surrounded by a paved walk 5 ft. wide. Find the area of the paving and the cost of laying it at 4s. 6d. per sq. yd.

22. A rectangular field 100 yd. 2 ft. long, and 60 yd. 1 ft. broad, has a path 4 ft. wide running round outside it. Find the area of the path in square feet.

23. A piece of cardboard 15 centimetres square weighs 27 grammes. What is the weight of a piece of the same cardboard 20 centimetres square?

24. A room 15 ft. by 12 ft. 6 in. has a carpet in the centre which leaves a margin of 9 in. uncovered all round the room. This margin is covered with linoleum of which a piece 4 ft. 6 in. wide costs 8s. 3d. a yard. If there is no waste in cutting, find the cost of the linoleum.

VOLUMES AND SURFACES OF RECTANGULAR SOLIDS

63. Volume of a Rectangular Solid.

Imagine a hollow rectangular solid, such as a box, with length of base 6 in., breadth of base 4 in., and height 9 in., the material being of negligible thickness.

We could place on the base 24 cubes of 1 in. side, since the area of the base is 24 sq. in.; and we could have 9 layers of these cubes.

$$\therefore \text{volume} = 216 \text{ cub. in.}$$

In general, $\text{volume} = \text{length} \times \text{breadth} \times \text{height}.$

Note once again, that the dimensions must be brought to the same unit before multiplying.

Ex. 1. Find the volume (or cubical contents) of a cistern 3 ft. 4 in. long, 2 ft. 6 in. wide, and 3 ft. deep.

$$\text{Volume} = 3\frac{1}{3} \times 2\frac{1}{2} \times 3 \text{ cub. ft.}$$

$$= \frac{10}{3} \times \frac{5}{2} \times 3 \text{ cub. ft.}$$

$$= 25 \text{ cub. ft.}$$

Ex. 2. If the volume of a solid is 528 cub. in., and $l = 5\frac{1}{2}$ in., $b = 4$ in., find h .

$$V = lbh,$$

$$h = \frac{V}{lb}$$

$$= \frac{528}{5\frac{1}{2} \times 4} \text{ in.}$$

$$= \frac{12}{\cancel{4} \cancel{8}} \times \frac{2}{\cancel{11} \times \cancel{4}} \text{ in.} = 24 \text{ in.} = 2 \text{ ft.}$$

64. Areas of surfaces of Rectangular Solids.

Top and bottom areas = lb sq. units each.

2 side areas = lh sq. units each.

Other 2 side areas = bh sq. units each.

$$\text{Total} = 2lb + 2lh + 2bh.$$

65. Ex. 1. Find the cost of painting all surfaces of an open cistern with a base 3 ft. by 2 ft. 6 in., and a height 3 ft. 6 in., at 2*d.* per sq. ft.

Note that each surface has a back and front, but that there is no lid.

$$\text{Two surfaces of base} = 2 \times lb = 2 \times 3 \times 2\frac{1}{2} \text{ sq. ft.} = 15 \text{ sq. ft.}$$

$$\text{Two surfaces of 2 sides} = 4 \times lh = 4 \times 3 \times 3\frac{1}{2} \text{ sq. ft.} = 42 \text{ sq. ft.}$$

$$\text{Two surfaces of other 2 sides} = 4 \times bh = 4 \times 2\frac{1}{2} \times 3\frac{1}{2} \text{ sq. ft.} = 35 \text{ sq. ft.}$$

$$\text{Total} = 92 \text{ sq. ft.}$$

$$\text{Cost} = 92 \times 2d.$$

$$= 184d.$$

$$= 15s. 4d.$$

Ex. 2. How many bricks 9 in. by 4½ in. by 3 in. are required to build a wall 6 ft. 6 in. long by 9 in. deep by 3 ft. 3 in. high, if 6 in. of the length and 3 in. of the height are caused by the thickness of the mortar?

$$\text{Volume of bricks in wall} = 72 \times 36 \times 9 \text{ cub. in.}$$

$$\text{Volume of one brick} = 9 \times 3 \times 4\frac{1}{2} \text{ cub. in.}$$

$$\begin{aligned} \text{No. of bricks} &= \frac{72 \times 36 \times 9}{9 \times 3 \times 4\frac{1}{2}} \\ &= 192. \end{aligned}$$

Ex. 3. If a cubic foot of water weighs 1000 oz., find the weight in pounds of a solid block of metal 9 in. by 4 in. by 3 in., if the metal is 7½ times as heavy as water.

$$\text{Volume of metal} = 9 \times 4 \times 3 \text{ cub. in.}$$

$$= \frac{9 \times 4 \times 3}{1728} \text{ cub. ft.}$$

$$\text{Wt. of water of this volume} = \frac{9 \times 4 \times 3}{1728} \times 1000 \text{ oz.}$$

$$\begin{aligned} \text{Wt. of metal} &= \frac{9 \times 4 \times 3 \times 1000 \times 125}{1728 \times 2} \\ &= \frac{1875}{4} \text{ oz.} \end{aligned}$$

$$= 468\frac{3}{4} \text{ oz.}$$

$$= 29 \text{ lb. } 4\frac{3}{4} \text{ oz.}$$

EXERCISE 31 (a). MENTAL.

Find the volumes of the following rectangular solids:

| | Length | Breadth | Height |
|-----|---------|---------|------------------|
| 1. | 6" | 5" | 4" |
| 2. | 8" | 4" | 5" |
| 3. | 4' 6" | 4' | 4' |
| 4. | 2' 6" | 2' 6" | 4' |
| 5. | 2.5 cm. | 2.3 cm. | 8 cm. |
| 6. | 15 mm. | 10 mm. | 5.2 mm. |
| 7. | 21 ft. | 12 ft. | 6 ft. (cub. yd.) |
| 8. | 7½" | 6" | ¾" |
| 9. | 24" | 18" | 16" (cub. ft.) |
| 10. | 27' | 18' | 21' (cub. yd.) |

11. Find the volume of a cube having a total surface area of 384 sq. in.

12. A rectangular solid 12 ft. long and 7½ ft. wide has a volume of 30 cub. yd. What is its thickness?

13. A cistern 6 ft. each way has 18 cub. ft. of water in it. What is the depth of water?

14. What volume of water falls on a surface 240 ft. by 100 ft. if the rainfall for the period is .35 inches.

15. How many cubic metres are there in a block 8 m. long, 80 cm. wide, 50 cm. thick?

16. A cube has a volume 64,000 cub. in. What is the area of one face?

17. How many blocks 6" by 5" by 4" can be placed in a box with internal dimensions 6' by 5' by 8'?

18. A box contains 4 billiard balls of 2" diameter placed side by side. If the balls will just fit into the box, what is its internal volume?

19. A cubic foot of water weighs 1000 oz. What is the weight of a block 15.15 ft. by .4 ft. by .25 ft., composed of a substance 4 times as dense as water.

20. Find the cost of a solid block of material 15" by 6" by 4½" at 6d. a cubic inch.

EXERCISE 31 (b).

Find the volumes of the following rectangular solids:

| | Length | Breadth | Thickness or Height | Answer required |
|-----|--------------------------|--------------------|---------------------|-----------------------------------|
| 1. | 5 ft. 6 in. | 3 ft. 6 in. | 2 ft. 4 in. | cub. ft.; cub. in. |
| 2. | $8\frac{3}{4}$ in. | $5\frac{1}{2}$ in. | $\frac{1}{10}$ in. | cub. in. |
| 3. | 4 ft. 9 in. | 2 ft. 4 in. | 1 ft. 8 in. | cub. ft.; cub. in. |
| 4. | $3\frac{1}{2}$ yd. | $2\frac{1}{2}$ yd. | 1 ft. 3 in. | cub. ft.; cub. in. |
| 5. | 3.16 in. | 2.95 in. | .15 in. | cub. in.; to 3 places |
| 6. | 3 m. 14 cm. | 2 m. 15 cm. | .05 cm. | cub. cm. |
| 7. | 145 cm. | 12.5 cm. | .5 cm. | cub. cm.; to the nearest cub. cm. |
| 8. | 4.23 in. | 3.85 in. | 1.25 in. | cub. in.; to 3 places |
| 9. | 1 ft. $8\frac{1}{4}$ in. | $8\frac{1}{2}$ in. | $\frac{1}{8}$ in. | cub. in. |
| 10. | 2.35 yd. | 1.25 ft. | .64 in. | cub. in. |

11. Find the area of the largest surface in Question 1.

12. What is the area of the smallest surface in Question 3?

13. Find the area of the base of the solid in Question 5.

14. Find the total surface of the solid in Question 7.

15. What is the total surface of a cube with an edge of 1.45 in.?

16. If the volume of a solid is 15.72 cub. in., and the thickness is 1.34 in., what is the area of cross-section?

17. A rectangular solid has a volume of 1592 cub. in. The height is 15 in., and the length 35 in. What is the breadth?

18. If the length of a rectangular solid is 1 ft. 4 in., the breadth 8 in., and the volume 576 cub. in., what is the height?

19. Using the formula $V = l \times b \times h$, write down an expression from which the breadth may be found if V , l and h are known.

20. Use this formula to find b to 2 places if $V = 3.875$, $l = 2.25$ and $h = .15$.

EXERCISE 81 (c).

1. What is the cost of painting the surface of a cube of 10 in. side at $2d.$ per sq. ft.?

2. A plank is 7 in. wide and $2\frac{1}{2}$ in. thick. What length of plank contains a cubic foot of timber?

3. A box 3 ft. long and 2 ft. wide exactly holds 2304 packages measuring 3 in. by 2 in. by $1\frac{1}{2}$ in. How deep is the box?

4. How many bricks will be required to build a wall 30 ft. long and 14 ft. high? The walls are one brick in thickness and each brick is 9 in. by $4\frac{1}{2}$ in. by 3 in.

5. The water in an iron tank 3 ft. 3 in. by 2 ft. 9 in. is 1 ft. 9 in. deep. What is the volume of the water? If the water is completely frozen, what will be the volume of the ice if water expands 9 per cent. when frozen?

6. A trench is dug across a piece of land and measures 1.3 Kilometres when completed. If the trench has an average depth of 1.7 m. and an average breadth of 78 cm., how many cubic metres of soil have been removed?

7. What is the weight of a rectangular block of marble of uniform thickness if the dimensions are 3 m. 50 cm., 1 m. 54 cm., and 6 cm.? 1 c.c. of marble weighs 2.7 grammes.

8. If 1 cub. cm. of water weighs one gramme and a cubic centimetre of ice weighs 0.918 gramme, by how many cubic centimetres does the volume of one Kilogram of ice exceed the volume of one Kilogram of water?

9. A cubic foot of water weighs 1000 oz. Find in tons, correct to the nearest ton, the weight of a rainfall of 1 in. over an area of a quarter of an acre.

10. A rectangular cistern without a lid measures internally 18 ft. 6 in. long, 15 ft. wide, and 9 ft. deep. Find the cost of painting the outside at $1s. 1\frac{1}{2}d.$ per sq. yd.

11. A square block of iron of sides 1 ft. 9 in., and 1 ft. 3 in. deep is made into rods of which the rectangular ends are $\frac{3}{4}$ in. by $\frac{1}{2}$ in. Find the total length of the rods.

12. How many bricks 9 in. by $4\frac{1}{2}$ in. by $2\frac{1}{2}$ in. will be required to build a wall $\frac{3}{4}$ mile long, 10 ft. high, and $2\frac{1}{4}$ ft. thick?

13. A rectangular steel plate is 42 ft. long and $3\frac{1}{2}$ ft thick, and has a volume of 1543 cub. ft. 864 cub. in. What is the width of the plate?

14. A rectangular cistern is 142 centimetres long, $1\frac{1}{2}$ metres broad and 8 decimetres deep. How many gallons will it hold if 1 gallon = 4544 cubic centimetres?

15. A rectangular stack of floor boards is 6 ft. high, 5 ft. broad, and 24 ft. long. Find the number of boards in the stack if each board is 5 in. by $\frac{3}{4}$ in. by 12 ft.

16. Find the weight of a single board in Question 15 if the wood weighs 35 lb. per cub. ft.

17. A sheet of lead weighs 100 lb. Find the area it will cover, to the nearest square foot, if it is $\frac{1}{16}$ in. thick, and the lead weighs 712 lb. per cub. ft.

18. A plank of wood 16 ft. long, 1 ft. wide, and 3 in. thick is to be cut into blocks 9 in. by 3 in. by 1 in. How many blocks could be cut out?

19. A canal is 20 yd. wide, and 12 ft. deep, and water passes steadily through it at the rate of 1 mile per hour. Find the flow of water through the canal in cubic feet per minute.

20. The total surface of a cube is 18 sq. ft. 54 sq. in. Find the length of an edge of the cube.

MENSURATION OF THE CIRCLE AND OF SOLIDS INVOLVING THE CIRCLE.*

66. Circumference of Circle.

If the circumference (C) of a circle is measured—e.g., by rolling a circular disc along a straight line—it is found that the ratio of its length to the length of the diameter (D) is always the same. This ratio is about $3\frac{1}{7}$, or more accurately 3.14159 . It is known as π (called pi).

$$\frac{C \text{ (circumference)}}{D \text{ (diameter)}} = \pi.$$

$$\therefore C = \pi D$$

$$\text{or } C = 2\pi r.$$

Ex. 1. Find the circumference of a circle of radius $3\frac{3}{4}$ in.

$$C = 2\pi r$$

$$= 2 \times \frac{22}{7} \times 3\frac{3}{4} \text{ in.}$$

$$= 16\frac{5}{2} \text{ in.} = 23\frac{1}{2} \text{ in.}$$

Ex. 2. A circle has a circumference of 25 in. Find the diameter.

$$C = \pi D.$$

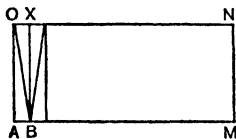
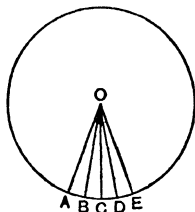
$$D = \frac{C}{\pi}$$

$$= \frac{25 \times 7}{22} \text{ in.}$$

$$= 17\frac{5}{2} \text{ in.} = 7\frac{31}{2} \text{ in.}$$

67. Area of Circle.

Cut out a circle by means of very narrow sectors, all of the same size, as indicated in the first diagram.



* This section will be dealt with more fully in Part II, and may therefore be postponed.

Place them all together, turning alternate sectors upside down as shown in the second diagram, where four of the sectors are indicated.

If the sectors are very narrow indeed, so narrow that the points A, B, C, D, E etc. are almost exactly touching, we shall obtain approximately a rectangle $AMNO$, of which one side is the radius of the circle and the other is *half* the circumference, since half the sectors are turned upside down.

$$\therefore \text{Area of circle} = r \times \pi r.$$

$$\bigcirc = \pi r^2.$$

Ex. 1. Find the area of a circle of diameter 22.4 in.

$$\text{Diameter} = 22.4 \text{ in.}$$

$$\text{Radius} = 11.2 \text{ in.}$$

$$\text{Area} = \frac{22}{7} \times (11.2)^2 \text{ sq. in.}$$

$$= \frac{22}{7} \times \frac{8}{5} \times \frac{56}{5} \text{ sq. in.}$$

$$= \frac{2856}{5} \text{ sq. in.} = 394.24 \text{ sq. in.}$$

More accurately:

$$\bigcirc = 3.1416 \times (11.2)^2$$

$$= 3.1416 \times 125.44 \text{ sq. in.}$$

$$= 394.08 \text{ sq. in., correct to 2 places.}$$

Ex. 2. Find the circumference of a circle of area 154 sq. in.

$$\bigcirc = \frac{22}{7} r^2 = 154.$$

$$\therefore r^2 = \frac{7 \times 154}{22} = 49.$$

$$r = 7 \text{ in.}$$

$$\therefore C = 2 \times \frac{22}{7} \times 7 = 44 \text{ in.}$$

68. Volume of Cylinder.

It is useful to note that the volume of any solid of which the cross-section is the same at all heights is found by multiplying the area of cross-section by the height.

$$\therefore \text{Volume of Cylinder} = \pi r^2 h.$$

69. Volume of Cone.

The proof of this formula, or even an easy demonstration of it, is difficult. Its truth must therefore be taken for granted, namely $V = \frac{1}{3}\pi r^2 h$.

I.e. the volume of a cone is one-third that of the cylinder with the same base and height.

70. Volume of Sphere.

This formula also must be taken for granted, i.e.

$$V = \frac{4}{3}\pi r^3.$$

71. Curved Surface of Cylinder.

If the curved surface is stretched out flat it will make a rectangle of which the breadth is the height of the cylinder and the length is the circumference of the base.

$$\begin{aligned}\therefore \text{Surface} &= h \times 2\pi r \\ &= 2\pi rh.\end{aligned}$$

72. Curved Surface of Cone.

Here Surface = $\pi r l$, where l is the *slant* height.

73. Curved Surface of Sphere.

$$S = 4\pi r^2.$$

74. Ex. 1. Find the curved surface of a cone with height 6 in., and a base of radius 4 in.

Let l = slant height,

$$l^2 = r^2 + h^2 = 16 + 36 = 52,$$

$$l = \sqrt{52} \text{ in.} = 7.2 \text{ in.},$$

$$\text{Surface} = \pi r l = \frac{22}{7} \times 4 \times 7.2 \text{ sq. in.} = 90.5 \text{ sq. in.}$$

Ex. 2. Find the total surface of a hemisphere of radius $3\frac{1}{2}$ cm.

Total surface = base + curved surface

$$= \pi r^2 + 2\pi r^2 = 3\pi r^2,$$

$$\begin{aligned}\text{Area in sq. cm.} &= 3 \times \frac{22}{7} \times (3\frac{1}{2})^2 = 3 \times \frac{22}{7} \times \frac{49}{4} \\ &= 115\frac{1}{2} \text{ sq. cm.}\end{aligned}$$

EXERCISE 32 (a). MENTAL.

Give *statements only* for the following. Do not work them out.

1. The area of a circle of radius (a) r ; (b) 5 in.
2. The area of a circle of diameter (a) D ; (b) 7 in.
3. The radius of a circle of area (a) A ; (b) 18 sq. in.
4. The diameter of a circle of area (a) A ; (b) 250 sq. cm.
5. The area of a semicircle of radius (a) r ; (b) 17 ft.
6. The area of a semicircle of diameter (a) D ; (b) 15 sq. in.
7. The circumference of a circle of radius (a) r ; (b) 8 in.
8. The circumference of a semicircle of diameter (a) D ; (b) 3·7 in.
9. The diameter of a circle of circumference (a) C ; (b) 25·3 in.
10. The volume of a sphere of radius (a) r ; (b) 2 in.
11. The volume of a sphere of diameter (a) D ; (b) 2·3 ft.
12. The radius of a sphere of volume (a) V ; (b) 4851 cu. ft.
13. The diameter of a sphere of volume (a) V ; (b) $3\frac{78}{121}$ cu. ft.
14. The volume of a cylinder (a) with base of radius r , and height h ; (b) with base of radius 7 in., and height 9 in.
15. The volume of a cone (a) with base of radius r , and height h ; (b) with base of radius 3 in., and height 6 in.
16. The curved surface of a cylinder (a) with base of radius r , and height h ; (b) with base of radius 6 cm., and height 12 cm.
17. The curved surface of a cone (a) with base of radius r , and slant height l ; (b) with base of radius 5 in., and slant height 7 in.
18. The surface of a sphere of radius (a) r ; (b) 5·3 in.
19. The total surface of a hemisphere of radius (a) r ; (b) 3 in.
20. The volume of a cylinder surmounted by a hemisphere, (a) if the radius in each case is r , and the height of the cylinder is h ; (b) if $r = 3\cdot5$ in. and $h = 9\cdot8$ in.

EXERCISE 32 (b).

1—20. Work out as accurately as you think necessary the statements given in Ex. 32 (a).

EXERCISE 32 (c).

$$\pi = 3\frac{1}{2}.$$

1. What is the volume of the largest possible cylinder that can be placed in a cubical box of 7 in. internal edge?

2. What is the weight of a sphere of 6 in. diameter if 1 cubic inch weighs 7 oz.?

3. How many times does a wheel 3 m. 25 cm. in circumference revolve in travelling 19·5 Kilometres?

4. A brass tube, 2 ft. 11 in. long, has an outside diameter of 2 in. and an inside diameter of 1·8 in. If a cubic inch of brass weighs ·29 lb., find the weight of the tube.

5. A circular tunnel, 2 miles long and 14 ft. in diameter, is to be constructed. Find the weight of earth to be removed, assuming that one cubic yard of earth weighs 2,700 lb.

6. A dozen golf balls are to be painted. Find the area required to be painted if the balls are $1\frac{1}{2}$ inches in diameter.

7. A conical heap of corn is 10 ft. in diameter at the bottom and 4 ft. high. Find its contents in bushels and its weight in lb. assuming that 1 cu. ft. = $6\frac{1}{4}$ gallons and 1 bushel of the corn weighs 40 lb.

8. A hemispherical boiler is 2 ft. in diameter inside and is full of water. How many cylindrical tins, each 6 in. high and 3 in. in diameter, can be filled from the boiler?

9. A circular grass plot, of diameter 56 ft., is surrounded by a gravel path 7 ft. wide. Find the area of the path.

10. A map is drawn on a scale of 1 inch to the mile. How many acres would be represented by the area covered by a halfpenny placed on the map? [The diameter of a halfpenny is one inch.]

11. Find the cost to the nearest penny of the zinc used to make a cylindrical pail (without a top), the height of the pail being 3 feet and the diameter of the base 15 inches; having given that the cost of a sq. ft. of the zinc used is 9d.

12. A cubic foot of lead is melted and cast into spherical shot, 6·5% of the lead being wasted in the process. Find, to the nearest hundred, how many shot of diameter $\frac{1}{4}$ inch can be made from the lead. [The volume of a sphere is $\frac{4}{3}\pi r^3$.]

13. Two solid metal cylinders of heights 10 and 12 cm., and of diameters 6 and 8 cm. respectively, are melted together, and the molten metal is poured into a cylindrical mould whose diameter is 20 cm., and whose axis is vertical. To what height will the metal rise in the mould?

14. Water flows along a circular pipe of diameter 14 centimetres at 3 Kilometres per hour. How many litres does the pipe discharge per day of 24 hours?

15. A circular pit, 600 yards deep and 20 feet in diameter, is full of water. How many hours will it take a pump to empty the pit if the pump makes 6 strokes a minute and each stroke lifts 9 cubic feet of water?

16. Find the weight to the nearest lb. of 81 yards of copper wire of diameter 0.15 in. [A cubic foot of copper weighs 560 lb.]

17. The trunk of an oak tree is $22\frac{1}{2}$ feet in circumference and 44 feet high. Assuming that the thickness is the same all the way up find, to the nearest whole number, how many cubic feet of wood the trunk contains.

18. A running track, bounded by concentric circles of radii 210 feet and 224 feet, is to be laid with cinders to a depth of 18 inches. How many loads of cinders will be required, assuming that each load contains a cubic yard?

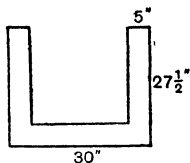
19. A cylindrical clock-weight of lead, of radius $1\frac{1}{2}$ inches and length 3 inches, is melted down with another of radius 2 inches and length $4\frac{1}{4}$ inches. The whole of the lead is made into a cylinder whose length is $3\frac{1}{2}$ inches. Find the radius of the new cylinder.

20. A roller with open ends is 3 ft. 6 in. wide and is made of cast iron 1 inch thick. Its external circumference is 7 ft. 4 in. Find its weight, assuming that a cubic foot of cast iron weighs 432 lb.

EXERCISE 33.

1. A wall of a room 7.4 metres long and 3.7 metres high is covered with wood 1.4 centimetres thick. Find in cubic decimetres the volume of wood used.

2. Find (i) the area, (ii) the sum of the lengths of the edges, of the figure represented in the accompanying diagram. The dimensions are given in inches, and the figure is everywhere 5 inches wide.



3. Find in cubic feet the volume of a tank 7 feet 5 inches long, 4 feet 6 inches wide, and 3 feet 4 inches deep.

4. A tank measuring 6 ft. by 4 ft. by 3 ft. is filled by a pipe $1\frac{1}{2}$ in. in diameter through which water flows at the rate of a foot a second. Find, to the nearest minute, how long it takes to fill the tank. [Take $\pi = 3\frac{1}{7}$.]

5. A floor 13 ft. $8\frac{1}{2}$ in. long and 8 ft. $1\frac{1}{2}$ in. wide is to be covered with tiles $7\frac{1}{2}$ in. long and $3\frac{1}{2}$ in. wide. How many tiles are required?

6. A strip of building land on the side of a straight road has a depth of 100 yards. It is sold at £7. 10s. per foot of road frontage. How much is this per acre?

7. An iron rod, whose section is a square of side 2.7 centimetres, weighs 10 Kilograms. Given that 1 cubic centimetre of iron weighs 7.7 grams, find the length of the rod to the nearest centimetre.

8. A rectangular piece of sheet lead of length 1.2 metres and breadth 34 centimetres weighs $11\frac{1}{2}$ Kilograms. Given that 1 cubic centimetre of lead weighs 11.3 grams, find the thickness of the sheet to the nearest tenth of a millimetre.

9. Find in Kilograms the weight of a rectangular slab of marble $1\frac{1}{2}$ metres long, 27 centimetres broad and 6.5 centimetres thick, if 1 cubic centimetre of marble weighs 2.6 grammes.

10. A rectangular block of stone, 2 ft. 3 in. long, 1 ft. 8 in. broad, and $3\frac{1}{2}$ inches thick, weighs 176 lb. Find, to the nearest lb., the weight of 1 cubic foot of the stone.

11. With gravel at 25s. a load of 1 cubic yard, find the cost of the gravel to cover, one inch deep, a garden path 185 ft. long and 3 ft. 6 in. broad.

12. Given that lead weighs 710 lb. to the cubic foot, find the thickness of sheet lead that weighs 6 lb. to the square foot. Give the answer to the nearest hundredth of an inch.

13. A sheet of copper, 2 ft. 3 in. long by 1 ft. 3 in. broad and $\frac{1}{16}$ of an inch thick, weighs 8 lb. Find, to the nearest lb., the weight of a cubic foot of copper.

14. A room is 16 ft. by 12 ft. Find the cost of carpeting it with carpet 3 ft. wide at 7s. 6d. a yard length so as to leave a border all round 2 feet wide uncarpeted.

15. What weight of earth will be removed in boring a circular shaft, diameter 20 feet and depth 130 yards? The weight of 1 cubic foot of the earth may be taken as 160 lb.

16. What length of timber $6\frac{1}{2}$ inches wide and $1\frac{1}{2}$ inches thick will be required to cover a floor 13 ft. by 11 ft. 11 in.? How many cubic feet of wood will be required?

17. Find the length of the diameter of a circle which has an area equal to that of a square with a side of 22 feet.

18. A cistern holds 27 cu. ft. 1224 cu. in. of water. Its length is 3 ft. 9 in., and its breadth 3 ft. 2 in. What is its depth?

19. A rectangular copper plate of uniform thickness is 1.1 metres long and 21 centimetres broad; its weight is 4.8 Kilograms. From it is cut out a circular plate of diameter 21 centimetres. Find in grams the weight of the circular plate.

20. If the radius of a circular racing track measured from the centre to the inside edge be 56 yards, and the track be $3\frac{1}{2}$ yards wide, how much farther will the man on the outside have to run than the man on the inside edge?

21. A tank, 2.3 metres long, 1.7 metres wide, and 1.5 metres deep, is filled from another tank containing 1300 gallons of water. How much water, to the nearest gallon, remains in the latter tank? (1 litre = .22 gallon.)

22. The carpet of a room, which is 31 feet long, cost £24. 8s. 3d. at 5s. 3d. per sq. yd. What is the breadth of the room?

23. How many cubic feet of air are there in a bell tent which has a diameter at the ground of 14 feet and is 10 feet high?

24. The body of a tank is cylindrical, while each end is hemispherical. If it has a total length of 27 feet, and is 7 feet in diameter, what is its volume?

GENERAL REVISION.

EXERCISE 34 (a). MENTAL.

1. Write in £ s. d. to the nearest penny £0·881.
2. Express £4. 19s. 7d. as the decimal of £1 to three places.
3. Find the ninth part of £7. 17s. 9d.
4. What is the cost of 6125 articles at £2. 8s. per 1000?
5. Find the dividend on £5250 at 1s. in the £.
6. Find the cost of 3 lb. 7 oz. of beef at 1s. 4d. per lb.
7. 99×87 .
8. $3\frac{3}{7} \times 42$.
9. $2\frac{2}{3} \times 1\frac{1}{2}$.
10. $2\frac{1}{5} + 1\frac{1}{3}$.
11. Give the cube root of ·064.
12. Write down the approximate answer to £15. 19s. 11d. $\times \frac{3}{4}$.
13. If $29\cdot37 \div 49\cdot56 = x \div 4\cdot956$, find x .
14. Express 35 cm. as the decimal of 10 metres.
15. The dimensions of a room are as follows: length = 25 ft., breadth = 15 feet, height = 10 feet. What is the area of a long wall?
16. Give two approximate values of π (pi), one fractional and the other in decimal form.
17. Divide £2700 in the proportion 5 : 3 : 2.
18. If I can only save 5% of my income, which is £800 a year, how much do I spend in a year?
19. Find the average of 3·06, 4·08, 5·10.
20. At what price per dozen must I sell goods costing 5s. a gross so as to make 50% profit?

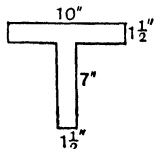
EXERCISE 34 (b).

1. $35\cdot106 \div 49\cdot5$, correct to 2 places.
2. $(5\frac{1}{2} - 3\frac{1}{4}) \div (0\cdot02)$.
3. Find the Simple Interest on £2471 for $1\frac{1}{2}$ years at $2\frac{1}{2}\%$.
4. Simplify, by means of prime factors or otherwise:

$$\frac{705 \times 1113}{1431 \times 1551}.$$

5. Find the cost of 15 yards 2 feet 10 inches at 7s. 6d. per yard.

6. If this figure is assumed to be regular but is not drawn to scale, calculate



- (1) the area,
- (2) the perimeter.

7. If 5 feet of wire weigh $4\frac{1}{2}$ oz., find the weight of a quarter of a mile in lbs.

8. Increase £257,654 by 12 %.

9. What is the total surface area of a cylinder and two hemispheres, all of which fit together to form one solid, if the radius of the base of the cylinder is 7 inches, and the height is 11 inches?

10. Find the net saving on 5 tons 17 cwt. of coal if 3 tons of it are reduced by $2\frac{1}{2}$ d. per cwt. and the rest by 10 per cent., the original cost being £2. 16s. per ton.

EXERCISE 34 (c).

1. If a metre is taken as 39·3708 inches, find in inches, and centimetres, correct to three decimal places, the difference between 10 cm. and 4 inches.

2. A line of railway is built by three firms, who employ on it 350, 270, 220 men respectively. If the construction of the railway costs £202,440, how much should each firm receive?

3. A man pays one-tenth of his income in rates and taxes, and one-twelfth in insurances. He has £735 left. What is his income?

4. 200 tons of coal were purchased for £160. 150 tons were sold at a profit of 20 % on the cost of it, and the remainder at a loss of 2s. per ton. What was the amount of the actual profit?

5. If the rateable value of a district is £565,144, how much, to the nearest £, does a levy of 1d. rate produce?

6. A county with a population of 1,126,465 has a Council of 58 members. How many members should a district of the county with a population of 56,014 have?

7. The circumference of a wheel is 2 metres 25 centimetres. Express in Kilometres the length of a path if the wheel makes 2376 revolutions when travelling along it.

8. A bankrupt paid 10s. 9d. in the £ dividend. His available assets were £1290. What did he owe?

9. A slab of marble 3·2 metres long and 35 cm. wide weighs 42 Kilograms. If a cubic cm. of marble weighs 2·5 gm., find the thickness of the slab.

10. *A* can do in 5 days what *B* can do in 4 days and *C* in 3 days; how long will all three working together take to do what *A* alone could do in 30 days?

EXERCISE 35 (a). MENTAL.

1. Write in words the number 307,260,008.
2. Find the cost of 3·3 yards of material if $\frac{3}{4}$ yd. costs 7s. 6d.
3. Work in one operation
 $£570 - (£212. 16s. 4d. + £15. 10s. 9d. + £115).$
4. $3125 \times 24.$
5. $3\cdot06 \div \cdot03.$
6. What is the cost of $2\frac{1}{2}$ gross at $1\frac{1}{2}d.$ for each article?
7. If 2809 and 3249 are both perfect squares, what are their square roots?
8. $\cdot2 \times \cdot3 \times \cdot5.$
9. $5\frac{1}{4}\%$ of £400.
10. Simplify $1 - (\frac{1}{2} + \frac{1}{4} + \frac{1}{8}).$
11. Simplify $\frac{\cdot3}{3} + \frac{\cdot5}{5} + \frac{\cdot8}{8}.$
12. Bring £5. 17s. $9\frac{1}{2}d.$ to the decimal of £1 correct to three places.
13. How many rectangles 2·5" by 1·5" can be cut from a rectangle 2 ft. 6 in. by 3 ft.?
14. Bring ·7125 ft. to inches.
15. Write down expressions for the following without working out the statement: the total surface of a cylinder of which the height is 15 cm. and the diameter of the base 4·5 cm.

16. Find the Simple Interest on £450 for 2 years at $3\frac{1}{2}\%$.
17. If 5 lb. 8 oz. of a certain substance cost 3s. 9d., what will 16 lb. 8 oz. cost at the same rate?
18. If goods costing £150 are sold for £200, what is the profit per cent., (a) reckoned on cost price, (b) reckoned on turnover?
19. How much must be invested at $4\frac{1}{2}\%$ in order to give an annual income of £45?
20. Two trains are travelling towards one another at rates of 55 and 35 miles an hour respectively. What is their relative velocity?

EXERCISE 35 (b).

1. Add 1·0167, 2·0555, 3·0714135 and 1·62406185, and give the answer correct to three decimal places.
2. $1428\cdot06 \times 1\cdot0296$.
3. Find the Compound Interest on £750 for 3 years at $3\frac{1}{2}\%$.
4. What is the cost of 510·9 yd. of material at 7s. 2d. per yard?
5. Find the cost of 17 cwt. 3 qr. 14 lb. at £3. 10s. 0d. per ton.
6. Simplify $14\frac{3}{4} - (4\frac{7}{8} \text{ of } 2\frac{2}{3})$.
7. Six men can do a piece of work in 48 hr. 20 min. How long would it take eight men to do a similar piece of work?
8. Goods were bought at £4. 15s. 0d. per dozen and sold at a profit of 5% . What was the selling price of one article?
9. How many packets measuring 5 in. \times 4 in. \times 4 in. can be packed in a box whose internal measurements are 3 ft., 1 ft. 8 in., 1 ft. 4 in.?
10. If a bankrupt pays £100. 10s. 0d. on a debt of £150. 15s. 0d., how much does he pay in the £?

EXERCISE 35 (c).

1. A train travels at 50 miles per hour. Express this speed in feet per second correct to the nearest foot.
2. The first £225 of a man's income is exempt from income tax; the remainder of his income is taxed at the rate of 3s. in the £. If he pays £32. 5s. in income tax, what is his total income?

3. A man deposits £2475 in a bank and receives interest at the rate of 1% per annum. Find to the nearest penny the total amount at the end of 200 days.

4. An open tank is 8 feet long, 5 feet wide, and 4 feet deep. Find the amount of paint required to paint it inside, if one lb. of paint will cover 72 square feet.

5. When a rupee is worth 1s. $4\frac{3}{10}d.$, how many rupees can be bought for £13. 9s. $9\frac{1}{2}d.$?

6. A firm employing 25 hands pays out £3716. 19s. in wages in 52 weeks. Find, to the nearest penny, the average weekly wages of each employee.

7. How many pieces of wire 3.85 inches long could be cut from a roll containing 85.7 yards?

8. A merchant owes £10,000 and becomes bankrupt. His assets amount to £5480. How much does he pay in the £? What will a creditor lose to whom he owes £250?

9. A lump of alloy weighing 11.76 lb. contains 4.9 lb. of copper and the rest is composed of other metals. What weight of copper is there in 1 cwt. of this alloy?

10. A dealer bought 35 doz. penholders at a shilling a score, and sold 9 score of them at 11d. per dozen. At what price per doz. must he sell the remainder to clear 25% on the whole?

EXERCISE 36 (a). MENTAL.

1. What is the value of .375 of £4?

2. Find the Simple Interest on £15. 10s. 0d. for 1 year at $2\frac{1}{2}\%$.

3. What is the cost of $1\frac{1}{4}$ dozen eggs at $1\frac{3}{4}d.$ each?

4. Write down the difference between 3.1 lb. and 1.85 lb. in ounces.

5. Express £3.833 in £ s. d.

6. Find the cost of $\frac{1}{2}$ cwt. at $1\frac{1}{2}d.$ per lb.

7. What is $8\frac{1}{3}\%$ of £15?

8. Write down the L.C.M. of 3, 5, 12, 30.

9. Give the next two terms of the series 3, 4.5, 6.5, 9.0....

10. Simplify $\frac{\frac{1}{2} + \frac{1}{3}}{\frac{1}{2} - \frac{1}{3}}$.

11. What is the volume of material in a plank 24 feet long, 6 in. wide and $\frac{1}{2}$ in. thick?

12. What is the postage for a letter weighing 11 oz., if the rate is $1\frac{1}{2}d.$ for the first two ounces and $\frac{1}{2}d.$ for each additional two ounces?

13. If I sell for 15s. 9d. articles which I buy for £1, what is the percentage loss?

14. Find the cost of 5.75 metres of cloth at 16 francs per metre.

15. Simplify 2.375×32 .

16. Write down the number which represents the total of a quarter of a million and one thousand and six.

17. Simplify $.152 \div .008$.

18. What will be the cost of 15 score of articles at 5s. per dozen?

19. Find the weight of 24 cu. ft. of material twice as heavy as water if a cubic foot of water weighs 62.5 lb.

20. Simplify $\frac{2.24 \times .52}{8.96 \times .13}$.

EXERCISE 36 (b).

1. Simplify $1\frac{3}{4} + \frac{5}{8} + (1\frac{7}{8} \times \frac{3}{10})$.

2. Express 78 grams as a decimal of half a Kilogram.

3. Find the value of $\frac{3}{4}$ of £4. 2s. 3d. — £1.06875.

4. Find the amount of £264 in 7 months at 5% per annum simple interest.

5. At what price must an article which cost 2s. 6d. be sold to give a profit of 15 per cent. on the outlay?

6. A rectangular playing field covers an area of .00375 of a square mile. Find the breadth, to the nearest yard, if the length is $135\frac{1}{4}$ yards.

7. Calculate the cost, to the nearest penny, of 3 tons 12 cwt. 3 qr. 16 lb. at £7. 12s. 6d. per cwt.

8. Find the price obtained for 19,516 acres of land, sold at an average of £6. 17s. 6d. per acre.

9. Find the value of £7. 8s. 8d. in French money to the nearest centime at the time when £1 was worth 83·40 francs.

10. An aeroplane flew 253 miles in 2 hours 25 minutes. Express this in feet per second, to the nearest foot.

EXERCISE 36 (c).

1. In 1914 the population of Stepney was 279,804, the birth-rate was 29·6 per thousand, and the death-rate 15·1 per thousand. What was the excess of births over deaths for the year?

2. A bankrupt pays 11s. 8d. in the pound. How much will be lost by a creditor whose claim amounts to £734. 15s. 6d.?

3. If 1 metre = 39·37 in., how many metre lengths can be cut from a ball of string containing 50 yards? Find to the nearest inch the length of the remaining piece.

4. Stone weighs 2·6 grams per cubic centimetre. Find the thickness of a stone slab 75 centimetres long, 32 centimetres broad, which weighs 22 Kilograms. Answer to the nearest millimetre.

5. A certain sample of square copper wire weighs 555 lb. to the cubic foot. Find the area of cross-section of copper wire which weighs 185 lb. to the mile.

6. If 34 lb. of coffee be worth 28½ lb. of tea, and 14 yards of cloth be equal in value to 20 lb. of coffee, and tea cost 2s. 10d. per lb., what are 21 yards of cloth worth?

7. The cost of making a tar footpath is about 2s. 6d. per sq. yd. What will a path 400 feet long and 6 feet wide cost?

8. A Jersey cow gives 38·5 lb. of milk in 24 hours, which produces 2 lb. 1 oz. of butter. Find the percentage of butter fat in the milk.

9. How long will a car take to travel a mile at the rate of 20 Km. per hour if a Km. = 0·6214 mile? Give the answer to the nearest second.

10. On what date will £2208 repay a sum of £2190 borrowed on the 1st Feb. 1928 at 5 per cent. per annum Simple Interest?

EXERCISE 37 (a). MENTAL.

1. $3\cdot0186 - 1\cdot987$.
2. Find the cost of 480 articles at $1s. 1\frac{1}{2}d.$ each.
3. If I buy goods for £176. 10s. 0d. and sell them at a profit of £44. 2s. 6d., what is my percentage of profit?
4. Find the value of £0·185 to the nearest penny.
5. Divide £39 between *A* and *B*, giving *A* £4. 10s. more than *B*.
6. What is the cost of 117 articles at $19s. 11d.$ each?
7. Express as a fraction, $3\cdot125 + \cdot375 + \cdot875$.
8. If 1 cwt. cost £2. 2s., what will 14 lb. cost?
9. Simplify $\frac{3\cdot125 - 2\cdot085}{\cdot02}$.
10. Find the Simple Interest on £350 for 2 years at 4% .
11. How many postage stamps $\frac{3}{4}$ in. by $\frac{7}{8}$ in. would exactly cover an area 3 in. by 1 ft. 2 in.?
12. Find the volume of a sphere of radius 1 inch.
13. If I gain 5% by selling an article for $1s. 9d.$, what shall I lose by selling it for $1s. 7d.$?
14. Simplify $4\cdot125 \times 2400$.
15. Simplify $3\frac{1}{5} + 4\cdot7 + 2\frac{1}{2}$.
16. What is the area of the border round a carpet 3 yards square in a room 10 ft. by 12 ft.?
17. Divide 2·05 by 0·041.
18. What is the cost of 78 articles at $2s. 6d.$ per dozen?
19. If $259 \times \cdot00876 = x \times 8\cdot76$, find x .
20. Write down the next two terms of the series $2\frac{1}{6}, 2\frac{1}{3}, 2\frac{1}{2}, 2\frac{2}{3}, \dots$

EXERCISE 37 (b).

1. Find the value to two places of decimals of $\frac{3}{7} + \frac{5}{16}$.
2. Simplify $\frac{3\frac{2}{3} + 2\frac{3}{4}}{5\frac{1}{4} - 1\frac{1}{8}} \div 3\frac{1}{7}$.
3. Find to the nearest sixpence the rent of a field of 15 acres 3 roods 33 poles at 26 shillings an acre.
4. A rectangular grass plot, 72 metres long and 55 metres wide, is surrounded by a path 1·5 metres wide; find the area of the path.
5. Find the prime factors, and hence the H.C.F. and L.C.M. of 312 and 270.
6. Find, to the nearest penny, the Simple Interest on £3750 for 200 days at $5\frac{1}{2}\%$ per annum.
7. Two bales of cotton of the same quality are worth £15. 6s. and £18. 14s. 6d. respectively. If the smaller weighs 2 cwt. 1 qr. 20 lb., what does the other weigh?
8. Simplify 0·56 of £2. 10s. 0d. + 1·425 of 13s. 4d. - 8·875 half-crowns.
9. Find, to the nearest penny, the cost of 565 yards of fencing at £100 per mile.
10. If butter sold in Paris in 1921 at 23·40 francs per Kilogramme, what was that in English money if £1 = 58·5 francs?

EXERCISE 37 (c).

1. A man invests £3175 in a business, and his dividend after one year is £238. 2s. 6d. What rate per cent. of interest is he getting?
2. A gallon of water weighs 10 lb. Find the weight of half a pint of mercury, if mercury is $13\frac{1}{2}$ times as heavy as water.
3. Out of ten tons of potatoes, 15 cwt. 3 qr. were found to be bad. What percentage of the whole were sound?
4. A merchant buys apples at £54 per ton and the price is increased by one-sixth for freight. At what price per lb. to the nearest farthing must he sell so that a quarter of what he receives may be profit?

5. One man starts from a place A at 9 a.m. to motor to B , 32 miles away, at 15 miles per hour. Another man starts from B at 9.30 a.m. and motors towards A at 20 miles an hour. Where do they meet?

6. A man works 44 hours a week ordinary time and 7 hours overtime, each overtime hour being paid as an hour and a half. If his wages for the week are £4. 3s. $1\frac{1}{2}d.$, how much does he get for each hour overtime?

7. A piece of calico measuring 36 yards long is purchased at 1s. $10d.$ per yard, and is made up into sheets 3 yards long after allowing half an inch for hem stitching each end. How many sheets are made?

8. A trader marks his goods at 40% above cost price, but allows a cash discount of 10%. Find the real percentage of profit.

9. A room is $17\frac{1}{2}$ feet long and $14\frac{1}{2}$ feet wide, and there is a border 1 ft. 6 in. wide all round the carpet. What will the carpet cost at 9s. per sq. yd.?

10. A man invests three equal amounts in concerns paying dividends of 5 per cent., 4 per cent. and 3 per cent., and receives a total income of £3600. Find the sum invested in each concern.

E.M.E.U.

Central Schools' Examination, 1927.

ARITHMETIC. (Compulsory.)

MONDAY, 27th June.

INSTRUCTIONS TO CANDIDATES.

Read the instructions carefully before answering questions.
Neglect to do this may entail serious loss of marks.

Answer any six questions.

All questions are of equal value.

1. Work mentally:

(a) $\frac{3}{32}$ ft. to inches.

Answer.....

(b) $\frac{7}{10}$ oz. to lbs.

Answer.....

(c) $95418 \div 47$.

Answer.....

(d) Simplify $\frac{3\frac{2}{5}}{38}$.

Answer.....

(e) $\cdot 1 \times \cdot 2 \times \cdot 3$.

Answer.....

(f) Find the product of the two threes in $\cdot 37$ and $\cdot 53$.

Answer.....

(g) $13\cdot 8 \div 400$.

Answer.....

(h) A postage stamp is $\frac{3}{4}$ in. by $\frac{7}{8}$ in. Find its area.

Answer.....

(i) Express £2·783 in £ s. d.

Answer.....

(j) Express 17s. 10½d. as a decimal of £1.

Answer.....

2. Make out a bill for the following:

$1\frac{3}{4}$ lb. of tea at 2s. 8d. per lb.

1 stone of sugar at $5\frac{1}{2}$ d. per lb.

$1\frac{1}{2}$ lb. of butter at 1s. 10d. per lb.

$2\frac{3}{4}$ lb. of bacon at 1s. 8d. per lb.

1 stone of flour at 2s. 7d. per stone.

If I pay for the above with two one-pound notes, find (a) what fraction of the £2 the change is, (b) what per cent. the change is of £2.

3. A grocer received a sum of money for the coffee he sold, and twenty-eight times this amount for the sale of tea. In all he received £44. 6s. 11d. Find what he received for the tea.

4. (a) If $\frac{7}{11}$ of a ton of coal costs £1. 3s. 11d., find the cost of a ton.

(b) A rent collector receives $2\frac{1}{2}\%$ on the amount he collects. If he receives £4. 7s. 6d., find the amount collected.

5. A rope is 5 Hm. 9 m. 3 cm. long. Express this length in metres. If one metre of the rope weighs 209 grams, find the weight of the rope in Kilograms.

6. A cistern is 8.4 ft. long, 5.5 ft. wide, and holds 720 gallons when full. If one gallon of water occupies 277.2 cub. in., find the depth of water in the cistern when it is full.

7. I paid .2 of my money for a tie, and .6 of the remainder for a hat. The hat cost 4s. 8d. more than the tie. Find what money I had left and what I paid for the hat. (Work in decimals if you can.)

8. Three packets weigh respectively $\frac{2}{7}$ of a stone, $\frac{4}{3}$ lb. and $\frac{3}{8}$ oz. Find their average weight in lbs.

9. By selling a suit for £3. 19s. 6d. I gain 6%. What per cent. would have been gained if it had been sold for £3. 17s. 3d.

ROYAL SOCIETY OF ARTS.

Junior School Commercial Certificate.

JULY, 1927.

ARITHMETIC.

*Two hours allowed.**The Arithmetic Paper is divided into two Parts—*

MENTAL and WRITTEN.

Part I.—Mental Arithmetic. [30 minutes allowed.]*The answers to be written down in the spaces provided.**No calculations on paper allowed.*

1. Add each column and each row in the following table, and write the results in the blank spaces:

| £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. |
|------|----|----|------|----|----|-----|----|----|-------|----|----|
| 105 | 14 | 7 | 123 | 2 | 6 | 321 | 7 | 7 | ..... |  |  |
| 3046 | 4 | 1 | 1311 | 6 | 1 | 316 | 11 | 6 | ..... |  |  |
| 302 | 13 | 2 | 3060 | 7 | 11 | 15 | 7 | 9 | ..... |  |  |
| 136 | 11 | 9 | 25 | 10 | 6 | 284 | 16 | 5 | ..... |  |  |
| 392 | 13 | 7 | 810 | 17 | 5 | 89 | 8 | 6 | ..... |  |  |
| 1083 | 4 | 5 | 623 | 19 | 4 | 63 | 9 | 8 | ..... |  |  |
| 2345 | 9 | 2 | 2304 | 13 | 3 | 147 | 15 | 10 | ..... |  |  |
| 861 | 17 | 8 | 861 | 14 | 8 | 45 | 11 | 8 | ..... |  |  |
| 11 | 2 | 4 | 9573 | 2 | 10 | 1 | 7 | 6 | ..... |  |  |
| 304 | 18 | 6 | 169 | 11 | 11 | 386 | 19 | 8 | ..... |  |  |
| 51 | 6 | 8 | 587 | 9 | 5 | 29 | 3 | 7 | ..... |  |  |
| 1089 | 17 | 10 | 23 | 8 | 3 | 45 | 18 | 5 | ..... |  |  |
| £ | | | £ | | | £ | | | £ | | |

2. Write below in £ s. d. to the nearest penny

£827 . £5·483

=====

3. Write below in decimals of £1 correct to 3 places

£3. 6s. 7d. £5. 7s. 10d.

=====

4. Find the value of 8 dozen articles at 4s. 4½d. each.

Answer.....

5. Find the value in £ s. d. of ⅝ of a guinea.

Answer.....

6. Find the value in £ s. d. of 33⅓ % of £4.

Answer.....

7. Find the value of $3\cdot01 \times \cdot002 \times \cdot01$.

Answer.....

Part II.—Written.

The working of these sums must be shown clearly, fully, and neatly in the books provided.

1. If the price of coal is lowered 3½d. per cwt., by how much is the price of 35,187 tons decreased?

2. Find the amount of the following bill:

3½ lb. of butter at 1s. 10½d. a lb.

1 lb. 4 oz. of cheese at 1s. 7d. a lb.

1½ gallons of milk at 3d. a pint.

2 doz. eggs at 1¾d. each.

3. In growing potatoes, artificial manures are used at the rate of 5¾ lb. per rod. How many hundredweight are required for a field of 7½ acres?

4. A wood-paving block measures 20·8 cm. by 12·4 cm. by 7 cm. Find, to the nearest Kilogram, the weight of 1600 such blocks if a cubic metre of the wood weighs 1020 Kilograms.

5. Find the Simple Interest on £768 for 7 months at $4\frac{3}{4}\%$ per annum.

6. A shopkeeper allows a discount of $9d.$ in the pound for cash off the marked price of his goods. What percentage does he make on goods sold for cash if his prices are marked to allow a profit of 25% on cost prices?

7. A continental train is timed to leave a station at 10.15 p.m. and to stop at another at 1.20 a.m. after a non-stop run of 184 Kilometres. Find the average rate in miles per hour, taking 8 Kilometres = 5 miles.

8. A field of $3\frac{1}{2}$ acres is twice as long as it is wide. Find the number of yards of fencing required to go round the field.

UNION OF EDUCATIONAL INSTITUTIONS.

Preliminary Commercial Group, Part I.

1927.

ARITHMETIC.

*Six questions only are to be attempted.**All working must be shown in full.*

1. Simplify $\frac{6\frac{2}{3} - 1\frac{1}{5} \times 3\frac{1}{2}}{2\frac{1}{2} + 3\frac{3}{4} - 1\frac{2}{3}} \div \frac{4}{629}.$

2. (a) Simplify $\frac{15.036 - 7.9456}{.025}.$

(b) (i) Find the value of £2.69375.

(ii) Give 7s. 7½d. as a decimal of £1.

3. A man cycled the following numbers of miles in six days: 21, 6, 14, 10, 38 and 19. How many miles did he cycle on the seventh day if his average number of miles a day for the seven days was 19 miles?

4. Find **by practice** the cost of

2 ton 9 cwt. 3 qr. 15 lb. at 16s. 4d. per cwt.

5. A contractor engages to clear a site in 5 days of 8 hours each. He employs 12 carts, each of which removes a load every 2 hours. At the end of 3 days only half the work is done. How many more carts must he employ in order to finish the work in the specified time?

6. If 7½ lb. of butter cost 18s. 9d., find in francs the cost of 1 Kg. of butter.

(£1 = 120 francs. 1 Kg. = 2½ lb.)

7. A firm bought £400 worth of goods and expected to gain £80 by selling them, but $\frac{2}{3}$ of the goods were destroyed by fire and the remainder only realised a net profit of 15% on their cost price. What was the total amount of the firm's loss?

8. A man borrowed a sum of money and paid 2s. a week interest. If this interest was calculated at $7\frac{1}{2}\%$ per annum, what sum did he borrow?

9. A square field has an area of 34,969 sq. yd. Find its perimeter.

10. Find the length of the diameter of a circle which has an area equal to that of a rectangle 22 ft. in length and 7 ft. in width.

(Take $\pi = 3\frac{1}{7}$.)

**UNION OF LANCASHIRE AND CHESHIRE
INSTITUTES.****Preliminary Commercial Course, Part I.****ARITHMETIC AND ACCOUNTS.**

TUESDAY, 22nd March, 1927.

GENERAL INSTRUCTIONS.

If the rules are not attended to, the exercise will be cancelled.

Not more than seven questions may be attempted.

All steps leading to the required result must be shown in immediate connection with the question.

Where a question consists of two or more parts, each part of the question correctly answered will receive marks, but to obtain full marks you must answer all the parts of the question.

1. (a) Express 17s. 9d. as the exact decimal of £1.
(b) Use the result obtained in (a) above to find the value of 1000 articles at 17s. 9d. each.
2. Find the value in £ s. d. correct to the nearest farthing of $£975 - £84375 - £28125 + £16865$.
3. (a) What is the value of $(\frac{1}{3} + \frac{3}{4} - \frac{5}{16} - \frac{3}{32})$ of 10s. 8d.?
(b) If $16.9 \times 125 = 2112.5$, write down the answer of 1.69×1.25 .
(c) Find the price of 11 handkerchiefs at the rate of £4. 10s. per gross.
4. The gross amount of an invoice subject to a trade discount of 10% and a cash discount of 5% is £25. Find the net amount of the invoice, supposing the payment is made promptly.
5. The floor of a rectangular room 28 ft. 6 in. long and 18 ft. wide is composed of wooden blocks 9 in. long and 3 in. wide. Find the cost of the blocks required, if each block costs $1\frac{1}{2}d$.
6. The selling price of a certain article is 9s. 2d., and 10% of this price is profit. Find (a) the cost price of the article, and (b) the rate per cent. of profit on the cost price.

7. Mr F. Foster, grocer, of Bury, buys 3 cwt. 2 qr. 14 lb. of sugar at £1. 12s. 8d. per cwt. from Messrs Smith & Co., Manchester. The goods were invoiced at £6. 10s. Find the amount of the error.

8. Silk is sold in Paris at 65 francs per metre. Find the corresponding price in shillings and pence per yard, when £1 is worth 120 francs and 1 metre = 39 inches.

N.B. Questions 7 (*b*), 9 and 10 were on Accounts.

NATIONAL UNION OF TEACHERS EXAMINATIONS.

COMMERCIAL ARITHMETIC. (Elementary.)

MONDAY, 9th May, 1927.

MENTAL ARITHMETIC.

Half-an-hour allowed for this paper.

*The answers to be written on this paper in the space provided.
Mental work only permitted.*

| Add | £ | s. | d. |
|----------------|--------------|-----------|----------|
| 892,643 | 8,975 | 16 | 3½ |
| 218,796 | 74,528 | 15 | 8¼ |
| 532,865 | 37,486 | 12 | 9 |
| 758,979 | 5,238 | 14 | 11¾ |
| 436,582 | 96,429 | 18 | 7½ |
| <u>927,978</u> | <u>4,785</u> | <u>12</u> | <u>4</u> |

| | £ | s. | d. | | hrs. | mins. | secs. |
|------|----------------|-----------|-----------|------|-----------|-----------|-----------|
| From | 578,963 | 13 | 5¼ | From | 74 | 43 | 29 |
| Take | <u>197,986</u> | <u>19</u> | <u>8¾</u> | Take | <u>38</u> | <u>56</u> | <u>42</u> |

Answers

| | | |
|---|---|-----------|
| 83729 + 28475 + 3968 + 43879 + 24657 + 65834 | = | ..... |
| 7,293,846 - 5,497,897 | = | .. . |
| £23. 15s. 8½d. + £375. 12s. 9¼d. + £69. 15s. 4¾d.
+ £756. 13s. 5d. + £97. 16s. 10½d. | = | . . |
| £5643. 9s. 7½d. - £2876. 14s. 9¾d. | = | . . |
| Cost of 35 articles at 5s. 6d. per dozen | = | . |
| Value of 6 cwt. 28 lb. of coal at £3. 5s. per ton | = | |
| 13s. 9½d. expressed as decimal of £1 to 3 places | = | ... . . . |
| $\frac{2}{3}(\frac{3}{4} - \frac{2}{3})$ in lowest terms | = | ..... |
| 2.05 ÷ 0.041 | = | .. . . . |
| 37½ % of £36 | = | |
| Simple Interest on £75 for 1½ years at 6 %
per annum | = | |
| Buying price, 7s. 6d.; sale price, 8s. 9d.; gain
per cent. | = | |

NATIONAL UNION OF TEACHERS EXAMINATIONS.

COMMERCIAL ARITHMETIC. (Elementary.)

MONDAY, 9th May, 1927.

Two hours allowed for this paper.

Not more than nine questions are to be answered, and the working should be clearly shown. Full marks will be awarded only for the most direct methods.

1. (a) What decimal of a yard is 1 ft. $3\frac{3}{4}$ in. ?
(b) If 0.285 of $x = £1. 8s. 6d.$, what is x ?
2. (a) How many miles are travelled in 5 hours 35 mins. at $18\frac{3}{4}$ miles per hour ?
(b) Divide the sum of $3\frac{5}{6}$ and $5\frac{8}{9}$ by $21\frac{1}{2}$.
3. What is the value of 9 bags each containing 6 cwt. 3 qr. 12 lb. of rice at $£1. 17s. 4d.$ per cwt. ?
4. Find the total cost of: $15\frac{1}{2}$ yards of calico at $1s. 1d.$ per yd.; $7\frac{1}{4}$ yards of linen at $2s. 3d.$ per yd.; $8\frac{3}{4}$ yards of flannel at $3s. 7d.$ per yd.; 22 ounces of wool at $6s.$ per lb.
5. A stock of boots sold for $£105$ at $17s. 6d.$ a pair. How much would the sale have yielded if they had been sold at $18s. 9d.$ a pair?
6. Use a table of nine multiples to find how much more 5276 articles would cost than 3589 articles, at $£1. 17s. 10\frac{1}{2}d.$ each.
7. A room is 18 ft. long and 12 ft. wide. The two long walls and one short wall are boarded to a height of 3 ft. 6 in. with boards 7 in. wide. How many feet of boarding are used ?
8. Find, to the nearest penny, the Simple Interest on $£738$ for 8 months at $4\frac{1}{2}\%$ per annum.
9. What profit will be made if 8 ton 15 cwt. of potatoes are bought at $£7. 12s. 6d.$ per ton and sold at 28 lb. for $2s. 4\frac{1}{2}d.$?

10. After a discount of 15% had been allowed, an invoice was settled for £47. 16s. 3d. What was the gross amount of the invoice?

11. How much per cent. is gained by selling for 17s. 11d. an attaché case which cost 12s. 6d.?

12. About how long should a ladder be so that its top will just reach a window-sill 23 ft. from the ground when its foot is on the ground 14 ft. from the wall of a house?

TABLES

ENGLISH

Money.

| | |
|--------------------------------------|----------------------------------|
| 4 farthings=1 penny (<i>d.</i>) | $\pounds \frac{1}{2} = 10s.$ |
| 12 pence=1 shilling (<i>s.</i>) | $\pounds \frac{1}{5} = 6s. 8d.$ |
| 20 shillings=1 pound (\pounds) | $\pounds \frac{2}{3} = 13s. 4d.$ |
| <hr/> | $\pounds \frac{3}{4} = 15s.$ |
| $\pounds 1 = 240d.$ | $\pounds \frac{1}{8} = 2s. 6d.$ |
| $= 960f.$ | $\pounds \frac{3}{8} = 7s. 6d.$ |
| 1 florin=2 <i>s.</i> | $\pounds \frac{5}{8} = 12s. 6d.$ |
| 1 half-crown=2 <i>s.</i> 6 <i>d.</i> | $\pounds \frac{7}{8} = 17s. 6d.$ |
| 1 crown=5 <i>s.</i> | $\pounds 1\frac{1}{2} = 1s. 8d.$ |
| 1 half-sovereign=10 <i>s.</i> | $\pounds 1\frac{1}{5} = 1s. 4d.$ |
| 1 guinea=21 <i>s.</i> | $\pounds 1\frac{1}{8} = 1s. 3d.$ |

Weight—Avoirdupois.

| |
|-----------------------------------|
| 16 drams=1 ounce (oz.) |
| 16 ounces=1 pound (lb.) |
| 28 pounds=1 quarter (qr.) |
| 4 quarters=1 hundredweight (cwt.) |
| 20 hundredweights=1 ton |

| |
|-------------------------|
| <hr/> 112 lb.=1 cwt. |
| 2240 lb.=1 ton |
| 14 lb.=1 stone |
| 8 stones=1 cwt. |
| 1 lb. (Av.)=7000 grains |

Weight—Troy.

| |
|----------------------------------|
| 24 grains=1 pennyweight (dwt.) |
| 20 pennyweights=1 ounce (oz.) |
| 12 ounces=1 pound (lb.) |
| <hr/> 1 lb. Troy=5760 grains |
| 1 grain Troy=1 grain Avoirdupois |

TABLES

Length

12 inches (in.)=1 foot (ft.)

3 feet=1 yard (yd.)

220 yards=1 furlong (fur.)

8 furlongs=1 mile

5½ yards=1 pole

40 poles=1 furlong

22 yards=1 chain

10 chains=1 furlong

1760 yards=1 mile

6 feet=1 fathom

Square Measure.

144 sq. inches=1 sq. foot

9 sq. feet=1 sq. yard

4840 sq. yards=1 acre

640 acres=1 sq. mile

30¼ sq. yards=1 sq. pole

40 sq. poles=1 rood

4 roods=1 acre

10 sq. chains=1 acre

Cubic Measure.

1728 cub. in.=1 cub. ft.

27 cub. ft.=1 cub. yd.

Capacity.

4 gills=1 pint (pt.)

2 pints=1 quart (qt.)

4 quarts=1 gallon (gall.)

2 gallons=1 peck (pk.)

4 pecks=1 bushel (bush.)

8 bushels=1 quarter (qr.)

Time.

| | |
|-------------------|-----------------|
| 60 seconds (60'') | = 1 minute (1') |
| 60 minutes | = 1 hour |
| 24 hours | = 1 day |
| 7 days | = 1 week |
| 4 weeks | = 1 lunar month |
| 52 weeks | = 1 year |
| <hr/> | |
| 28 days | = 1 lunar month |
| 365 days | = 1 year |
| 366 days | = 1 leap year |

Thirty days hath September,
 April, June and November;
 All the rest have 31
 Excepting February alone,
 Which has but 28 days clear,
 And 29 in each leap year.

Leap years are divisible by 4, but
 centuries, in order to be leap years,
 must be divisible by 400.

Common Percentages and their Equivalents.

| | | | |
|-------|-----------------------------|-------|---------------|
| 1 % | = $\frac{1}{100}$ = .01 | 1 % | of £1 = 2.4d. |
| 2½ % | = $\frac{1}{40}$ = .025 | 2½ % | " = 6d. |
| 3⅓ % | = $\frac{1}{30}$ = .0333... | 3⅓ % | " = 8d. |
| 5 % | = $\frac{1}{20}$ = .05 | 5 % | " = 1s. |
| 7½ % | = $\frac{3}{40}$ = .075 | 7½ % | " = 1s. 6d. |
| 10 % | = $\frac{1}{10}$ = .1 | 10 % | " = 2s. |
| 12½ % | = $\frac{1}{8}$ = .125 | 12½ % | " = 2s. 6d. |
| 20 % | = $\frac{1}{5}$ = .2 | 20 % | " = 4s. |
| 25 % | = $\frac{1}{4}$ = .25 | 25 % | " = 5s. |
| 33⅓ % | = $\frac{1}{3}$ = .333... | 33⅓ % | " = 6s. 8d. |
| 37½ % | = $\frac{3}{8}$ = .375 | 37½ % | " = 7s. 6d. |
| 40 % | = $\frac{2}{5}$ = .4 | 40 % | " = 8s. |
| 50 % | = $\frac{1}{2}$ = .5 | 50 % | " = 10s. |
| 60 % | = $\frac{3}{5}$ = .6 | 60 % | " = 12s. |
| 62½ % | = $\frac{5}{8}$ = .625 | 62½ % | " = 12s. 6d. |
| 66⅔ % | = $\frac{2}{3}$ = .666... | 66⅔ % | " = 13s. 4d. |
| 75 % | = $\frac{3}{4}$ = .75 | 75 % | " = 15s. |
| 80 % | = $\frac{4}{5}$ = .8 | 80 % | " = 16s. |
| 87½ % | = $\frac{7}{8}$ = .875 | 87½ % | " = 17s. 6d. |
| 90 % | = $\frac{9}{10}$ = .9 | 90 % | " = 18s. |
| 100 % | = 1 = 1.0 | 100 % | " = £1 |

METRIC

Money.

1 French Franc = 100 centimes

1 German Mark = 100 pfennigs

1 American Dollar = 100 cents

Approximate Rates of Exchange.

(August 1928.)

£1 = 124 French francs

= 175 Belgian francs

= 4.85 American dollars

Weight.

10 milligrams (mg.) = 1 centigram (cg.)

10 centigrams = 1 decigram (dg.)

10 decigrams = 1 gram (g.)

10 grams = 1 Dekagram (Dg.)

10 Dekagrams = 1 Hectogram (Hg.)

10 Hectograms = 1 Kilogram (Kg.)

1 gram = 1000 milligrams

1 Kilogram = 1000 grams

Length.

10 millimetres (mm.) = 1 centimetre (cm.)

10 centimetres = 1 decimetre (dm.)

10 decimetres = 1 metre (m.)

10 metres = 1 Dekametre (Dm.)

10 Dekametres = 1 Hectometre (Hm.)

10 Hectometres = 1 Kilometre (Km.)

1 metre = 1000 mm.

= 100 cm.

1 Kilometre = 1000 m.

Square Measure.

| | |
|------------------------|-----------------------|
| 100 square millimetres | = 1 square centimetre |
| 100 square centimetres | = 1 square decimetre |
| 100 square decimetres | = 1 square metre |
| 100 square metres | = 1 square Dekametre |
| 100 square Dekametres | = 1 square Hectometre |
| 100 square Hectometres | = 1 square Kilometre |

| | |
|--------------------|-------------|
| 1 square Dekametre | = 1 are |
| 100 ares | = 1 Hectare |

Cubic Measure.

| | |
|------------------------|-----------------------------|
| 1000 cubic millimetres | = 1 cubic centimetre (c.c.) |
| 1000 cubic centimetres | = 1 cubic decimetre |
| 1000 cubic decimetres | = 1 cubic metre, etc. |

| | |
|---------|--------------------------|
| 1 litre | = 1 cubic decimetre |
| | = 1000 cubic centimetres |

COMMON EQUIVALENTS

1 cubic foot of water weighs about 1000 ounces, or approximately 62·3 pounds, or:

“A pint of pure water
Weighs a pound and a quarter.”

1 gallon of water weighs about 10 pounds

3 pennies weigh 1 ounce

A quartern loaf weighs 4 lb.

The diameter of a halfpenny = 1 inch

1 Knot = 1 Nautical mile per hour

= 1000 fathoms per hour

π = 3·1416 to 4 places of decimals

= 3½ approximately

1 metre = 39·37 inches approximately

8 Kilometres = 5 miles ,,

5 Kilograms = 11 pounds ,,

1 litre = 1·76 pints ,,

1 cubic centimetre of water at 4° C. weighs 1 gram

MENSURATION FORMULAE

| | |
|-----------------------------|--|
| Area of parallelogram | $= b \times h$; (b = base, h height) |
| Area of triangle | $= \frac{1}{2} b \times h$; (b = base, h = height) |
| Area of trapezium | $= \frac{1}{2} h (a + b)$; (a and b are \parallel sides, h = height) |
| Volume of rectangular solid | $= l \times b \times h$; (l = length, b = breadth, h = height) |
| Volume of pyramid | $= \frac{1}{3}$ (area of base) \times height |
| Area of circle | $= \pi r^2$; (r = radius) |
| Circumference of circle | $= 2\pi r = \pi d$; (d = diameter) |
| Volume of sphere | $= \frac{4}{3} \pi r^3$; (r = radius) |
| Surface of sphere | $= 4\pi r^2$ |
| Volume of cylinder | $= \pi r^2 h$; (r = radius of base, h = height) |
| Curved surface of cylinder | $= 2\pi r h$ |
| Volume of cone | $= \frac{1}{3} \pi r^2 h$; (r = radius of base, h = height) |
| Curved surface of cone | $= \pi r l$; (l = slant height) |

ANSWERS

ANSWERS

EXERCISE 1 (a).

1. 204,116. 2. 310,064. 3. 118,700. 4. 2,400,016. 5. 45,070,056.
6. Twenty-five thousand and eighteen.
7. Four hundred and sixty thousand, three hundred and eight.
8. One million, two hundred and fifty-six thousand, three hundred and four.
9. Fifty million, five hundred and six thousand and forty.
10. Two hundred and seventy-nine million, two hundred and sixty thousand, three hundred and five.
11. 19. 12. 18. 13. 126. 14. 221. 15. 44.
16. 1814. 17. 1140. 18. 1628. 19. 90,601. 20. 223,983.
21. 2998. 22. 14,817. 23. 2510. 24. 51,183. 25. 578,912.
26. 550,627. 27. 679 R. 6 or $679\frac{6}{8}$ or $679\frac{3}{4}$.
28. 3088 R. 6 or $3088\frac{6}{12}$ or $3088\frac{1}{2}$. 29. $11,231\frac{2}{5}$. 30. 9100.
31. 140,325. 32. 32,125. 33. 70,500. 34. 530. 35. 107.
36. Yes; yes; no; no.

EXERCISE 1 (b).

1. 3,725,167. 2. 6,477,464. 3. 5,898,202. 4. 2,299,599.
5. 8,798,863. 6. 5,664,810. 7. 23,011. 8. 69,105.
9. 378,245. 10. 96,497. 11. 344,898. 12. 1,712,791.
13. 1,168,101. 14. 946,750. 15. 896,104. 16. 599,130.
17. 623,025. 18. 7,632,076. 19. 280; R. 195. 20. 562; R. 624.
21. 2209; R. 13. 22. 41; R. 11302. 23. 329; R. 3750. 24. 70; R. 14650.
25. 96; R. 29093.

EXERCISE 1 (c).

1. 25 minutes. 2. 62,720 words. 3. 527,040 minutes.
4. 214,795. 5. 242^2 by 7911. 6. 15,840 inches.
7. 365 lb. 8. 277,927. 9. 136,080.
10. 12. 11. 5040. 12. $x = \pounds 127,020,868$.
 $y = \pounds 120,392,957$.
13. $\pounds 2,548,942$. 14. $\pounds 133,120$. 15. $\pounds 581,900$; $\pounds 531,900$; $\pounds 482,400$.

EXERCISE 2 (a).

1. $\pounds 34$. 17s. $0\frac{3}{4}d$. 2. $\pounds 3928$. 16s. $0\frac{1}{2}d$. 3. $\pounds 736$. 6s. $2\frac{1}{2}d$.
4. $\pounds 3606$. 6s. $4\frac{3}{4}d$. 5. $\pounds 950$. 7s. $4\frac{3}{4}d$. 6. $\pounds 22,636$. 5s. 11d.
7. $\pounds 12,505$. 17s. 11d. 8. $\pounds 4315$. 2s. $2\frac{1}{2}d$. 9. $\pounds 367$. 0s. 4d.
10. $\pounds 1411$. 9s. $6\frac{1}{2}d$. 11. $\pounds 1411$. 2s. $8\frac{1}{4}d$. 12. $\pounds 61,137$.
13. $\pounds 10$. 15s. 9d. 14. $\pounds 280$. 15. $\pounds 583$.

- | | | |
|------------------------------|----------------------------|---------------------------|
| 16. £7. 15s. 11½ <i>d.</i> | 17. £22. 16s. 7 <i>d.</i> | 18. £378. 6s. 8 <i>d.</i> |
| 19. £2857. 2s. 10¾ <i>d.</i> | 20. £78. 4s. 7½½ <i>d.</i> | 21. 125½ <i>d.</i> |
| 22. 2s. 0¼ <i>d.</i> | 23. £13. 19s. 0 <i>d.</i> | 24. £1. 0s. 1¼ <i>d.</i> |
| 25. £1. 4s. 9 <i>d.</i> | 26. £10. 1s. 4 <i>d.</i> | 27. 13s. 9 <i>d.</i> |
| 28. 1s. 9½ <i>d.</i> | 29. 95 farthings. | 30. 239 <i>d.</i> |

EXERCISE 2 (*b*).

- | | | |
|------------------------------|--------------------------------|--------------------------------|
| 1. £89,612. 2s. 5½ <i>d.</i> | 2. £52,628. 6s. 5½ <i>d.</i> | 3. £2137. 0s. 11¼ <i>d.</i> |
| 4. £37,548. 1s. 6½ <i>d.</i> | 5. £1239. 9s. 7¼ <i>d.</i> | 6. £52,289. 18s. 0 <i>d.</i> |
| 7. £55,359. 0s. 8¼ <i>d.</i> | 8. £1,144,516. 2s. 6 <i>d.</i> | 9. £1,294,789. 5s. 7 <i>d.</i> |
| 10. £148. 0s. 10¾½ <i>d.</i> | 11. £92. 17s. 2¾¼ <i>d.</i> | 12. £5. 7s. 7¾¾½ <i>d.</i> |
| 13. £3. 18s. 0¾¾½ <i>d.</i> | 14. 8438 half-pence. | 15. £124. 9s. 8 <i>d.</i> |

EXERCISE 2 (*c*).

- | | | |
|------------------------------|---|----------------------------|
| 1. £11,174. 1s. 10 <i>d.</i> | 2. £2875. 10s. 0 <i>d.</i> | 3. £1. 1s. 6 <i>d.</i> |
| 4. £53,149. 5s. 0 <i>d.</i> | 5. £73. 5s. 0 <i>d.</i> | 6. £3551. 13s. 4 <i>d.</i> |
| 7. £1. 0s. 6 <i>d.</i> | 8. 1976 times; £3. 2s. 11 <i>d.</i> over. | |

EXERCISE 3 (*a*).

- | | | | |
|-------------------|--------------------|----------------|--------------|
| 1. 88 half-pints. | 2. 32 qt. 1 pt. | 3. 280 gall. | 4. 31 lb. |
| 5. 660 yd. | 6. 560 lb. | 7. 500 lb. | 8. 7½ gall. |
| 9. 6500 oz. | 10. 17·28 cub. in. | 11. 40 chains. | 12. 92 days. |
| 13. 3¼ yd. | 14. 3 m.p.h. | 15. 2 lb. | 16. 140 lb. |
| 17. 48 in. | 18. 113 days. | 19. 45 cwt. | 20. 55 yd. |

EXERCISE 3 (*b*).

- | | |
|---|-------------------------------------|
| 1. 26 tons 11 cwt. 56 lb. | 2. 439 m. 6 fur. 8 ch. |
| 3. 17 gall. 2 qt. 1 pt. | 4. 66 cwt. 20 lb. |
| 5. 4 tons 16 cwt. 2 qr. | 6. 11 tons 2 cwt. 3 stone. |
| 7. 4 fur. 6 ch. 19 yd. | 8. 106 yd. |
| 9. 1 gall. 1 pt. | 10. 3 bushels 7 gall. 2 qt. |
| 11. 179 tons 18 cwt. | 12. 202 tons 7 cwt. 3 qr. |
| 13. 286 yd. | 14. 409 yd. 5 in. |
| 15. 150 gallons. | 16. 135 gall. 2 qt. 1 pt. |
| 17. 36 acres 4785 sq. yd. | 18. 58 acres 605 sq. yd. |
| 19. 1 cwt. 16½ lb. (or R. 50 lb.). | 20. 1 cwt. 74½ lb. (or R. 2 lb.). |
| 21. 5 fur. 2¼ ch. (or R. 45 ch.). | 22. 2 fur. 0¼¾ ch. (or R. 133 ch.). |
| 23. 337 sq. yd. 3¼ sq. ft. (or R. 1 sq. ft.). | |
| 24. 40 sq. yd. 2¼¾ sq. ft. (or R. 127 sq. ft.). | |
| 25. 7170 lb. | 26. 2512 oz. |
| 27. 254 half-pints. | 28. 4180 yd. |
| 29. 903 hours. | 30. 242,274 sq. ft. |
| 31. 19 tons 335 lb. | 32. 3 miles 708 yd. 1 ft. |

EXERCISE 3 (c).

- | | | |
|---------------------|----------------|--------------------|
| 1. 119 times. | 2. 100 miles. | 3. 32 tons 18 cwt. |
| 4. 160 yd., 110 yd. | 5. 75 litres. | 6. 36 lb. 7½ oz. |
| 7. 120 yd. | 8. 28 persons. | 9. £3. 4s. 0d. |
| 10. 64 miles. | | |

EXERCISE 4 (a).

- | | | | |
|----------------------|------------|-----------------------|------------------------------|
| 1. $\frac{7}{100}$. | 2. 1 ten. | 3. $\frac{13}{100}$. | 4. $\frac{9}{20}$. |
| 5. 5·9. | 6. 5·105. | 7. ·5288. | 8. 3858·295. |
| 9. 1·8. | 10. ·98. | 11. ·087. | 12. 103 cm. |
| 13. 1005 g. | 14. 35 m. | 15. 12 kg. | 16. 39,370·8 in. |
| 17. 14 pt. | 18. 33 lb. | 19. 2. | 20. 25; 25·1; 25·08; 25·075. |

EXERCISE 4 (b).

- | | | | |
|---|---------------|-------------------|--------------|
| 1. 8519·674. | 2. 1491·624. | 3. 1781·928. | 4. 582·6439. |
| 5. 20·345. | 6. 34·315. | 7. 861·2671. | 8. 7·2036. |
| 9. ·9776. | 10. 7·874. | 11. ·002567. | 12. 211·52. |
| 13. 649·225. | 14. 40·968 m. | 15. 1,005,650 mg. | |
| 16. Down: 230·8813, 521·7350, 979·118, 92·2199. | | | |

Across: 142·9128, 469·3127, 642·7306, 417·1401, 151·8580.

Total: 1823·9542.

EXERCISE 5 (a).

- | | | | | |
|---|------------|-----------|--------------------|---------------------|
| 1. 2×3^2 ; 7×5 ; $2 \times 3 \times 7$; $2 \times 5 \times 7$; $2^1 \times 3$. | | | | |
| 2. $2^2 \times 5$; 2×5^2 ; $2^2 \times 5^2$; $2^3 \times 5^2$; $2^2 \times 5^3$. | | | | |
| 3. 3×5 ; 5^2 ; 3×5^2 ; 5^3 ; 3×5^3 . | | | | |
| 4. 28. | 5. 9. | 6. 35. | 7. 15. | 8. 60. |
| 9. 24. | 10. 60. | 11. 102. | 12. 12, 9, 16, 10. | 13. 30, 27, 23, 24. |
| 14. 36. | 15. 10 oz. | 16. 10 s. | 17. 60 sec. | 18. 3 (9, 18, 27). |

EXERCISE 5 (b).

- | | | | |
|---|------------------------------|--|------------------------------|
| 1. 5×7^2 . | 2. $2 \times 3 \times 7^2$. | 3. $2^2 \times 3^3 \times 5$. | 4. $2^5 \times 3 \times 5$. |
| 5. $2^6 \times 3^3$. | 6. $5^2 \times 7^2$. | 7. H.C.F. $2^3 \times 3$ or 24; L.C.M. $2^6 \times 3^3 \times 7$. | |
| 8. H.C.F. $2 \times 3 \times 7$ or 42; L.C.M. $2^3 \times 3^3 \times 7 \times 11$. | | | |
| 9. H.C.F. 3×5^2 or 75; L.C.M. $2 \times 3^3 \times 5^3 \times 7$. | | | |
| 10. H.C.F. $2^3 \times 3^2$ or 72; L.C.M. $2^4 \times 3^3 \times 5$. | | | |
| 11. 71. | 12. 133. | 13. 561. | 14. 173. |
| 15. H.C.F. $3 \times 5^2 \times 7$; L.C.M. $3^2 \times 5^2 \times 7^2$. | | | |
| 16. H.C.F. $2 \times 3 \times 5^2$; L.C.M. $2^2 \times 3^2 \times 5^3 \times 11$. | | | |
| 17. H.C.F. $2^3 \times 11 \times 13$; L.C.M. $2^4 \times 11^2 \times 13$. | | | |
| 18. H.C.F. $5^2 \times 11$; L.C.M. $2 \times 5^3 \times 11^2 \times 17$. | | | |

EXERCISE 5 (c).

- | | | | |
|------------|--------------|--------------|----------------|
| 1. 3s. 4d. | 2. 30,940. | 3. 612. | 4. 72 seconds. |
| 5. 392 lb. | 6. 18 times. | 7. 5 inches. | |

EXERCISE 6 (a).

- | | | |
|----------------------|--------------|-------------------|
| 1. 7618. | 2. 3124. | 3. £33. 5s. 8½d. |
| 4. £22. 9s. 0d. | 5. 6425. | 6. 26 lb. 2 oz. |
| 7. £1. 2s. 6d. | 8. 3s. 3d. | 9. £1. 17s. 6d. |
| 10. £10. 10s. 0d. | 11. 2⁴ × 13. | 12. 1s. 2d. |
| 13. 4. | 14. 913. | 15. £1. 14s. 4½d. |
| 16. 8 m. 7 dm. 5 cm. | 17. 20,100. | 18. £1. |
| 19. £21. 1s. 9d. | 20. £320. | |

EXERCISE 6 (b).

- | | | |
|---|--|----------------|
| 1. 1,599,328. | 2. 113 $\frac{189}{1508}$ (or R. 189). | 3. 798,908 lb. |
| 4. £4492. 15s. 7½d. | 5. 1079 times. | 6. 166. |
| 7. 2³ × 3 × 5 × 7 × 11. | 8. 512 times. | 9. 28,175. |
| 10. £7. 1s. 7½d.; £21. 3s. 11d.; £11. 3s. 6¾d.; £16. 10s. 0d.; £3. 5s. 7¾d.; £11. 18s. 3½d. Total £71. 3s. 0½d. | | |

EXERCISE 6 (c).

- | | | |
|----------------------|----------------------------|--------------------|
| 1. 18½. | 2. 160 pairs. | 3. 11s. 6d. |
| 4. £18. 11s. 0d.; | £565. 10s. 0d.; | £12. 0s. 7½d.; |
| Total £634. 9s. 4½d. | | |
| 5. £18. | 6. £15,634. 5s. 0d. | 7. 1s. 5d. per lb. |
| 8. £55. | 9. 672 miles, 6·2 gallons. | 10. £2,280,800. |

EXERCISE 7 (a).

- | | | |
|--|-----------------------|---------------------------|
| 1. 448,288. | 2. £29,754. 16s. 9¾d. | 3. 5 miles 3 fur. 170 yd. |
| 4. 159,916. | 5. £52. 0s. 0¾d. | 6. £181. 14s. 1½d. |
| 7. 24 boys. | | |
| 8. Two hundred and ninety thousand and five. | | |
| 9. 7000. | 10. £3. 17s. 0d. | 11. £17. 10s. 0d. |
| 12. 13,425. | | |
| 13. 7s. 6d. | 14. £5. 5s. 0d. | 15. 5·486. |
| 16. 1288. | | |
| 17. 135 cm. | 18. 120. | 19. £91. 5s. 0d. |
| 20. £44. 8s. 0d. | | |

EXERCISE 7 (b).

- | | |
|--|---------------------------|
| 1. £2. 0s. 14 $\frac{8}{9}$ d. | 2. 86 tons 16 cwt. 43 lb. |
| 3. 11 miles 2 fur. 3 ch. 18 yd. 1 ft. | 4. 694. |
| 5. 45 (or 45½). | 6. £10,610. 12s. 6d. |
| 7. 12. | 8. 1155. |
| 9. 10½. | |
| 10. Down: 42,840; 167,342; 1,262,816; 246,587. | |
| Across: 63,391; 306,724; 169,809; 365,583; 673,437; 140,641. | |
| Total: 1,719,585. | |

EXERCISE 7 (c).

- | | | |
|-------------------------|--------------------------|--------------------------|
| 1. £5. 6s. 7½ <i>d.</i> | 2. 28 times. | 3. £141. 3s. 4 <i>d.</i> |
| 4. 7056, 7225, 7396. | 5. £6. 8s. 0 <i>d.</i> | 6. £3. 15s. 6½ <i>d.</i> |
| 7. 11. | 8. £2. 15s. 6¾ <i>d.</i> | 9. £6320. |
10. 2 lb. per hour.

EXERCISE 8 (a).

- | | | |
|-------------------------------|----------------------|---------------------------|
| 1. £483,990. 12s. 1 <i>d.</i> | 2. 106,404. | 3. 17 tons 12 cwt. 80 lb. |
| 4. 34,398. | 5. 45,488. | 6. 66,460½. |
| 7. 16. | 8. 808,010. | 9. 6 times. |
| 10. 15s. 9 <i>d.</i> | 11. 12s. 0 <i>d.</i> | 12. £9. 12s. 6 <i>d.</i> |
| 13. 365. | 14. 76,032. | 15. 1431. |
| 16. £1. 10s. 0 <i>d.</i> | 17. 151 cm. | 18. 1s. 8 <i>d.</i> |
| 19. £22. 1s. 0 <i>d.</i> | 20. 250,000. | |

EXERCISE 8 (b).

- | | | |
|------------|------------------------------------|---------------------|
| 1. 14. | 2. £18,701. 14s. 4½ <i>d.</i> | 3. 1,265,673 lb. |
| 4. 426 yd. | 5. 34 times; 2s. 9 <i>d.</i> over. | 6. 10,004.416 gram. |
| 7. 504. | 8. 896,103. | 9. 16,784. |
10. Down: 56,860; 94,568; 46,847; 52,688.
 Across: 185,995; 12,328; 24,656; 27,984.
 Total: 250,963.

EXERCISE 8 (c).

- | | | |
|--------------------------|--------------------------|-------------------------|
| 1. £8. 4s. 0 <i>d.</i> | 2. 60 miles per hour. | 3. 1717 ft. |
| 4. £2. 17s. 9¾ <i>d.</i> | 5. 2nd April, 1928. | 6. £14. 9s. 0 <i>d.</i> |
| 7. 55 marks. | 8. £197. 1s. 8 <i>d.</i> | 9. 25. |
10. £2. 18s. 3*d.*

EXERCISE 9 (a).

- | | | |
|--------------------------|-------------------------------|-------------------------|
| 1. 1835 yd. 2 ft. 7 in. | 2. £32,997. 12s. 6½ <i>d.</i> | 3. 125,136. |
| 4. £56. 9s. 6¾ <i>d.</i> | 5. £1003. 5s. 11½ <i>d.</i> | 6. £54. |
| 7. 12 tablets. | 8. 1,735. | 9. £4. 10s. 0 <i>d.</i> |
| 10. 25 minutes. | 11. 11s. 6 <i>d.</i> | 12. 8. |
| 13. 34,680. | 14. 11.693. | 15. £5. 6s. 3 <i>d.</i> |
| 16. 18. | 17. 5s. 0 <i>d.</i> | 18. 881 posts. |
| 19. 20; 100. | 20. £280. | |

EXERCISE 9 (b).

1. 180,838.
2. $191\frac{1999}{1000}$ (or R. 1904).
3. £52,596. 16s. $4\frac{1}{2}d$.
4. 5720 yd.
5. 3.41.
6. 43 times; 4 lb. 6 oz.
7. 478.
8. £22,398. 16s. 8d.
9. 2,571,000.
10. 16 miles 33 yd. 1 ft. 8 in.

EXERCISE 9 (c).

1. 17,526 francs.
2. 3 hr. 28 min.
3. $10\frac{5}{8}d$. per lb.
4. 12s. 0d.
5. 44,106,000.
6. 1s. 2d. per lb.
7. 314 miles.
8. 15s. $9\frac{3}{4}d$.; 8s. 6d.; 17s. $7\frac{1}{2}d$.; 6s. 5d.; 6s. $7\frac{3}{4}d$.; 8s. 9d.; 1s. 3d. Discount 1s. 6d. Total paid £3. 3s. 6d.
9. 1s. $10\frac{1}{2}d$. per lb.
10. £427.

EXERCISE 10 (a).

1. (a) $\frac{1}{4}^5$. (b) $\frac{3}{8}^1$. (c) $\frac{7}{11}^9$. (d) $\frac{12}{8}^3$. (e) $\frac{22}{10}^9$. (f) $\frac{21}{7}^2$.
(g) $\frac{18919}{9}$. (h) $\frac{17313}{11}$.
2. (a) $\frac{2}{1}^8$. (b) $\frac{2}{5}^1$. (c) $2\frac{1}{7}$. (d) $12\frac{1}{8}$. (e) $3\frac{1}{5}^1$. (f) $3\frac{1}{6}^6$.
(g) $200\frac{1}{20}$. (h) $1\frac{1}{35}\frac{1}{72}$.
3. (a) $\frac{5}{8}$. (b) $\frac{3}{4}$. (c) $\frac{1}{18}$. (d) $\frac{5}{9}$. (e) $\frac{9}{10}$. (f) $\frac{5}{8}$.
(g) $\frac{5}{12}$. (h) $\frac{8}{9}$.
4. (a) $\frac{2}{36}$. (b) $\frac{1}{27}$. (c) $\frac{100}{120}$. (d) $\frac{63}{72}$.
5. $\frac{1}{6}$. 6. 2. 7. $1\frac{1}{2}$. 8. $\frac{11}{14}$. 9. $4\frac{5}{8}$. 10. $4\frac{1}{8}$.
11. $\frac{1}{8}$. 12. $\frac{3}{8}$. 13. $\frac{1}{2}$. 14. $\frac{1}{6}$. 15. $\frac{1}{10}$. 16. $\frac{5}{12}$.
17. $1\frac{1}{2}$. 18. $\frac{5}{12}$. 19. £1. 0s. 8d. 20. 1 ton 1 cwt.
21. 1 yd. 9 in. 22. 12s. 6d. 23. 13 cwt. 24. 1 lb. 3 oz.

EXERCISE 10 (b).

1. (a) $\frac{3}{4}$. (b) $\frac{2}{3}$. (c) $\frac{7}{5}$. (d) $\frac{3}{8}$. (e) $\frac{9}{4}$.
2. (a) $17\frac{37}{43}$. (b) $10\frac{1}{10}$. (c) $11\frac{4}{9}$. (d) $3\frac{1}{2}$. (e) $40\frac{3}{8}$.
3. $6\frac{5}{12}$. 4. $\frac{1}{12}$. 5. $6\frac{5}{12}$. 6. $3\frac{5}{12}$. 7. 6.
8. $\frac{1}{3}$. 9. 3. 10. $\frac{1}{3}$. 11. $5\frac{1}{10}$. 12. $\frac{9}{10}$.
13. $9\frac{2}{30}$. 14. $\frac{3}{4}$. 15. $\frac{2}{3}$. 16. $1\frac{1}{10}$. 17. $9\frac{2}{30}$.
18. $5\frac{1}{2}$. 19. 1. 20. $18\frac{1}{12}$.

EXERCISE 10 (c).

1. $\frac{1}{2}$ left.
2. $\frac{5}{8}$.
3. $9\frac{1}{8}$ inches.
4. 12 ft.
5. 170 spent.
6. 40 miles.
7. $\frac{7}{30}$ left.
8. £2000.
9. $6\frac{1}{2}$.
10. Equal quantities.
11. £13. 17s. 6d.
12. $24\frac{1}{2}$ pt.

EXERCISE 11 (a).

- | | | | | | |
|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| 1. $\frac{8}{13}$. | 2. $\frac{10}{11}$. | 3. $\frac{45}{50}$. | 4. $\frac{19}{17}$. | 5. $\frac{1}{8}$. | 6. $\frac{2}{23}$. |
| 7. $2\frac{1}{2}$. | 8. $2\frac{1}{3}$. | 9. $\frac{8}{15}$. | 10. $\frac{1}{4}$. | 11. $\frac{5}{18}$. | 12. $\frac{8}{27}$. |
| 13. 2. | 14. 2. | 15. 1. | 16. 1. | 17. $\frac{1}{3}$. | 18. $\frac{1}{5}$. |
| 19. $\frac{1}{2}$. | 20. 2. | 21. $1\frac{1}{2}$. | 22. 3. | 23. 2. | 24. 25. |

EXERCISE 11 (b).

- | | | | | | |
|------------------------|-----------------------|------------------------|------------------------|-----------------------|-----------------------|
| 1. $18\frac{1}{3}$. | 2. 8. | 3. $1\frac{3}{4}$. | 4. $42\frac{1}{2}$. | 5. $\frac{33}{4}$. | 6. 1. |
| 7. 88. | 8. 15. | 9. $2\frac{1}{2}$. | 10. $1\frac{1}{4}$. | 11. $\frac{9}{4}$. | 12. $\frac{5}{8}$. |
| 13. $10\frac{5}{24}$. | 14. $1\frac{1}{35}$. | 15. $2\frac{2}{3}$. | 16. 296. | 17. $6\frac{1}{2}$. | 18. $2\frac{3}{40}$. |
| 19. $\frac{1}{120}$. | 20. $\frac{1}{90}$. | 21. $\frac{62}{115}$. | 22. $11\frac{9}{11}$. | 23. $3\frac{1}{4}$. | 24. $1\frac{3}{20}$. |
| 25. $2\frac{5}{81}$. | 26. $13\frac{1}{2}$. | 27. $3\frac{1}{4}$. | 28. $1\frac{1}{50}$. | 29. $\frac{23}{30}$. | 30. $\frac{1}{2}$. |
| 31. $5\frac{1}{6}$. | 32. $2\frac{3}{2}$. | 33. $2\frac{34}{25}$. | 34. $2\frac{3}{10}$. | 35. $\frac{19}{57}$. | 36. $5\frac{5}{39}$. |

EXERCISE 12 (a).

- | | | | | |
|--|---|-------------------|------------------|------------------|
| 1. $\frac{9}{10}, \frac{3}{5}, \frac{3}{4}, \frac{1}{20}, \frac{1}{400}$. | 2. $\cdot 6, \cdot 7, \cdot 875, \cdot 075, \cdot 0375$. | | | |
| 3. $5\cdot 615 \div 4\cdot 827$. | 4. $493\cdot 4 \times 4\cdot 516$ or $451\cdot 6 \times 4\cdot 934$. | | | |
| 5. $38\cdot 7 \div 1\cdot 65$. | 6. $\cdot 000573 \times 2\cdot 85$. | | | |
| 7. $153\cdot 9 \times 4\cdot 825$ or $482\cdot 5 \times 1\cdot 539$. | 8. $347\cdot 2 \times 4\cdot 394$ or $439\cdot 4 \times 3\cdot 472$. | | | |
| 9. $57\cdot 8 \times 5\cdot 64$ or $56\cdot 4 \times 5\cdot 78$. | 10. $38\cdot 59 \div 5\cdot 98$. | | | |
| 11. $\cdot 01$. | 12. $\cdot 06$. | 13. $\cdot 2$ | 14. $\cdot 12$. | 15. $\cdot 01$. |
| 16. $\cdot 1$. | 17. $\cdot 025$. | 18. $\cdot 075$. | 19. $\cdot 25$. | 20. $\cdot 2$. |

EXERCISE 12 (b).

- | | | | | |
|--------------|--------------|---------------|----------------|----------------|
| 1. 1·7739. | 2. 3·23625. | 3. 3·60995. | 4. ·004381008. | 5. ·000042256. |
| 6. ·4713348. | 7. 2·178423. | 8. 1·623125. | 9. ·057876. | 10. ·000625. |
| 11. 1·22. | 12. 107·65. | 13. 1·336. | 14. 3·31. | 15. 128·35. |
| 16. 131·9. | 17. 1·90. | 18. ·147. | 19. ·0245. | 20. ·0142. |
| 21. ·161. | 22. ·130. | 23. ·003. | 24. ·342. | 25. ·004. |
| 26. ·04. | 27. 283·616. | 28. 90. | 29. 2·1. | 30. 19·9. |
| 31. 10·4. | 32. 1·09. | 33. 32·03125. | 34. ·045. | 35. ·16. |

EXERCISE 13 (a).

- | | | | | |
|---------|---------|---------|---------|-----------|
| 1. 4. | 2. 5. | 3. 9. | 4. 10. | 5. 12. |
| 6. 16. | 7. 27. | 8. 24. | 9. 200. | 10. 1100. |
| 11. 18. | 12. 60. | 13. 80. | 14. 4. | 15. ·3. |
| 16. ·2. | | | | |

EXERCISE 13 (b).

- | | | | | | |
|------------|------------|-------------|-------------|-------------|------------|
| 1. 43. | 2. 78. | 3. 91. | 4. 105. | 5. 138. | 6. 146. |
| 7. 182. | 8. 234. | 9. 282. | 10. 378. | 11. 474. | 12. 666. |
| 13. 5·6. | 14. 17·3. | 15. 1·82. | 16. 37·7. | 17. ·466. | 18. ·438. |
| 19. ·389. | 20. 4·17. | 21. 20·976. | 22. 23·875. | 23. 25·807. | 24. 7·681. |
| 25. 1·414. | 26. 2·236. | 27. 3·742. | 28. 8·944. | 29. ·103. | 30. ·506. |
| 31. 1·410. | 32. 6·438. | | | | |

EXERCISE 13 (c).

- | | | | | | |
|-----------------------|-----------|-----------|------------|------------|-------------|
| 1. $2\frac{1}{2}$ ft. | 2. 13 in. | 3. 24 ft. | 4. 2·1 in. | 5. 5·9 in. | 6. 25·5025. |
| 7. 6·3 in. | 8. 15 ft. | | | | |

EXERCISE 14 (a).

- | | | | | |
|----------------------------|----------------------|-----------------------------|----------------------------|----------------------|
| 1. ·825. | 2. ·725. | 3. ·944. | 4. ·695. | 5. ·831. |
| 6. ·635. | 7. ·280. | 8. ·682. | 9. 3·890. | 10. 15·431. |
| 11. 5·640. | 12. 1·555. | 13. 17s. $10\frac{1}{4}d$. | 14. 10s. $9\frac{1}{4}d$. | 15. 13s. 5d. |
| 16. 11s. $6\frac{1}{4}d$. | 17. 17s. 4d. | 18. 14s. 7d. | 19. 7s. 10d. | 20. 14s. 9d. |
| 21. 17s. 3d. | 22. $\frac{3}{4}$ l. | 23. $\frac{1}{3}$ l. | 24. $\frac{1}{3}$ l. | 25. $\frac{2}{3}$ l. |
| 26. $\frac{1}{4}$ l. | 27. $\frac{4}{5}$ l. | 28. $\frac{7}{8}$ l. | 29. $\frac{5}{8}$ l. | 30. ·76. |
| 31. ·44. | 32. ·29. | 33. ·38. | 34. ·29. | 35. ·2. |
| 36. ·6. | 37. ·42. | 38. ·7. | 39. ·23. | 40. ·6. |

EXERCISE 14 (b).

- | | | | |
|---------------------------------------|--|--|----------------------------|
| 1. £3. 13s. $1\frac{1}{2}d$. | 2. £5. 14s. $0\frac{1}{4}d$. | 3. £4. 19s. $11\frac{3}{4}d$. | 4. £10. 2s. 1d. |
| 5. £1·87396. | 6. £4·64375. | 7. £49·69792. | 8. £3·85521. |
| 9. £4·25104. | 10. £10·15625. | 11. 14 cwt. 4 st. | 12. 2 ft. 6 in. |
| 13. 5 fur. 110 yd. | 14. 2 qt. | 15. 1 fur. 167 yd. | 16. 7 oz. |
| 17. $\frac{1}{3}\frac{2}{8}$; ·368. | 18. $\frac{1}{5}\frac{9}{11}$; ·695. | 19. $\frac{1}{14}\frac{9}{10}$; ·136. | 20. $\frac{7}{13}$; ·538. |
| 21. $\frac{5}{14}\frac{1}{3}$; ·357. | 22. $\frac{2}{5}\frac{7}{10}\frac{1}{7}$; ·538. | 23. $\frac{1}{3}$. | 24. 686 yd. |
| 25. 14s. $9\frac{3}{4}d$. | 26. £92. 3s. $6\frac{1}{4}d$. | 27. £64. 3s. 6d. | 28. £31. 13s. 9d. |
| 29. £31. 3s. $11\frac{3}{4}d$. | 30. £38. 6s. 9d. | | |

EXERCISE 14 (c).

- | | | | |
|---|--------------------|--------------------------------------|--------------------|
| 1. 21 oz. | 2. 400 gall. | 3. $5\frac{3}{4}d$. | 4. £7291. 13s. 4d. |
| 5. £40. | 6. 13s. 11d. | 7. 3·9 miles. | 8. 1687 kg. |
| 9. 105 metres. | 10. 22,496 francs. | 11. 30·43 in. | 12. 755 mm. |
| 13. 1221·68 francs. | 14. £8178. | 15. 53·6 m.p.h. | 16. ·4 cm. |
| 17. 91 pieces; $3\frac{3}{8}$ in. over. | | 18. 1s. 8d.; £2752. 3s. 9d. surplus. | |

EXERCISE 15 (a).

1. 2s. 6d.; 7s. 6d.; 12s. 6d.; 17s. 6d.
2. 4s.; 8s.; 12s.; 16s.
3. 1s. 8d.; 8s. 4d.; 11s. 8d.; 18s. 4d.
4. 1s. 4d.; 5s. 4d.; 9s. 4d.; 18s. 8d.
5. 1s. 3d.; 8s. 9d.; 3s. 9d.; 13s. 9d.
6. £ $\frac{2}{3}$.
7. £ $\frac{5}{6}$.
8. £ $\frac{1}{10}$.
9. £ $\frac{5}{8}$.
10. £ $\frac{1}{15}$.
11. 9s. 11d.
12. £4. 7s. 0d.
13. 15s. 7½d.
14. £1. 4s. 6d.
15. £21.
16. 10s. 5d.
17. 11s. 3d.
18. £5. 12s. 0d.
19. £1.
20. £3. 6s. 0d.
21. £1. 3s. 0d.
22. £1. 11s. 0d.
23. £49.
24. £55. 15s. 4d.
25. £1. 5s. 0d.
26. 16s. 0½d.
27. £3. 4s. 0d.
28. £56.
29. £2. 5s. 0d.
30. £13. 10s. 0d.
31. £264.
32. £240.
33. £7. 17s. 4d.
34. £8. 8s. 0d.
35. 16s. 8d.
36. £5. 5s. 0d.

EXERCISE 15 (b).

1. £1008.
2. £260. 18s. 1½d.
3. £286. 8s. 8½d.
4. £22,668. 8s. 10d.
5. £11,573. 19s. 4½d.
6. £20,100. 0s. 4½d.
7. £3359. 9s. 8¼d.
8. £120. 8s. 3d.
9. £7134. 15s. 0d.
10. £1336. 10s. 0d.
11. £26. 12s. 0d.
12. £16,104. 10s. 1d.
13. £11. 17s. 9d.
14. £346. 15s. 1¼d.
15. £325. 11s. 7½d.
16. £1861. 4s. 0d.
17. £11. 4s. 7d.
18. £272. 17s. 0½d.
19. £382. 9s. 10d.
20. £16,152. 7s. 6d.

EXERCISE 15 (c).

1. £9. 3s. 9d.; 7s. 10½d.; 5d.; 5s. 1¼d.; 1s. 2d.; 1s. 3¼d.; Total £9. 19s. 7d.
2. £1. 5s. 0d.; £1. 4s. 2½d.; £2. 4s. 3¼d.; £14. 15s. 6d.; 4s. 4¼d.
Total £19. 13s. 4d. Discount 9s. 6d. Total paid £19. 3s. 10d.
3. 2s. 11d.; 11¼d.; 11¼d.; 5s. 3d.; 1s. 4½d. Total 11s. 5d.
4. 4s. 2d.; 2s. 1d.; 7½d.; 5s. 9d.; £1. 3s. 9d. Total £1. 16s. 4½d.
5. £2. 9s. 4d.; £2. 16s. 2½d.; £5. 0s. 10d.; £3. 1s. 6d.; £1. 9s. 9d.;
£2. 12s. 3d. Total £17. 9s. 10½d. Discount 17s. 11d. Total paid £16. 11s. 11½d.
6. 5s. 9d. (1d. excess); 3s. 0½d. (accept 3s. 0½d. as correct); 7s. 3½d.
(½d. excess).
7. 16s. 3d.; £1. 6s. 3d.; 12s. 4½d.; 17s. 5¼d.; £2. 17s. 0d.; 5s. 6d.
Total £6. 14s. 9¾d.
8. £100. 14s. 0d.; £45. 10s. 0d.; £31. 2s. 9d. Total £177. 6s. 9d. Dis-
count £17. 14s. 8d. Total paid £159. 12s. 1d.
9. £3. 5s. 3d.; £1. 11s. 7½d.; £1. 7s. 0d.; £5. 14s. 7d.; £1. 6s. 0½d. Total
£13. 4s. 6d.

10. £10. 11s. 6d.; £2. 19s. 6d.; £20. 2s. 6d.; £23. 17s. 6d.; £8. 11s. 4½d.
Total £66. 5s. 4½d.

11. £1103. 5s. 6d. 12. £3. 3s. 9d. 13. 2s. 2d. per lb.
14. 21 doz. 15. £47. 10s. 0d. 16. £17,917. 12s. 0d.
17. £4. 18s. 11½d.; £19. 10s. 0d.; £17. 10s. 0d.; £5. 18s. 1½d. Total
£47. 17s. 1d.

18. £2. 7s. 3d.; £2. 3s. 9d.; £1. 11s. 10½d.; £1. 19s. 0d. Average price
per lb. 2s. 5d.

19. £2. 13s. 1½d.; 18s. 2½d.; 11s. 9¼d.; 1s. 9d. Discount 6s. 0d. Total
paid £3. 18s. 10¾d.

20. £1. 10s. 6d. 21. 5d. per pair. 22. £2646.
23. 157 lb. 24. 1s. 1½d.

EXERCISE 16 (a).

- | | | | |
|----------------|------------------|------------------|-------------------|
| 1. 3920. | 2. 1½. | 3. 7½. | 4. 15. |
| 5. £2. 2s. 0d. | 6. £883. | 7. 95·625. | 8. 33,000. |
| 9. 70·9. | 10. 3½. | 11. 170. | 12. £14. 14s. 0d. |
| 13. £575. | 14. 95·92. | 15. ·625; ·0375. | 16. 1⅓. |
| 17. ⅓, ⅕, ⅙. | 18. 10,010. | 19. 600. | 20. 3000·3. |
| 21. ·0625. | 22. 54·484. | 23. £5. 15s. 6d. | 24. 1⅒. |
| 25. ⅓. | 26. ⅔. | 27. 6. | 28. 9·105. |
| 29. £240. | 30. £12. 2s. 6d. | | |

EXERCISE 16 (b).

- | | | | |
|------------|------------|------------------|--------------------|
| 1. 1094. | 2. 21·045. | 3. £99. 8s. 6d. | 4. 1⅓. |
| 5. 13½. | 6. 1⅓. | 7. ·8. | 8. 1⅓. |
| 9. ¼. | 10. 4⅓. | 11. 2·500. | 12. 1⅓. |
| 13. 1⅓. | 14. 96. | 15. £3. 11s. 0d. | 16. £40. 14s. 9¼d. |
| 17. ·6875. | 18. 1½. | 19. 1⅓. | 20. 817. |

EXERCISE 16 (c).

- | | | |
|---|---|----------------------------|
| 1. £597. | 2. ·007, ·007, 700, ·7. | 3. £110. 8s. 0d. |
| 4. 63·9. | 5. £3. 10s. 0d.; £1. 4s. 4½d.; £2. 16s. 3d.; £1. 5s. 6d.; | |
| £1. 9s. 10½d. Total £10. 6s. 0d. Discount 6s. | | |
| 6. 4500 books. | 7. £24,200. | 8. 31. |
| 9. 24 ft. 8 in. approx. | 10. 60 gallons. | 11. 18s. 11d. per ton. |
| 12. 721 revolutions. | 13. 52·4 ft. per sec. | 14. £176,977. |
| 15. 1791 francs. | 16. 2s. 6·2d. per lb. | 17. 495 francs. |
| 18. 1 min. 17·8 sec. | 19. £138,225. 12s. 6d. | 20. £14. 18s. 8d. per cwt. |

EXERCISE 17 (a).

- | | |
|--------------------------------|---------------------------------|
| 1. £4905. 1s. $6\frac{1}{2}d.$ | 2. £326. 6s. $10\frac{1}{11}d.$ |
| 3. 30 tons 4 cwt. | 4. 2·34 km. |
| 6. 141. | 7. $\frac{1}{8}$. |
| 9. 9·005. | 10. 5040. |
| 12. 539 sixpences. | 13. £50. |
| 15. 20 ties. | 16. 18s. $6d.$ |
| 18. $\frac{2}{9}$. | 19. ·64. |
| | 20. £2. 1s. $3d.$ |
| | 11. 700 thousandths. |
| | 14. $\frac{1}{80}$ mile. |
| | 17. 6s. $9d.$ |

EXERCISE 17 (b).

- | | | |
|-----------------------|--|-------------------------|
| 1. $1\frac{1}{2}$. | 2. £44. 1s. $8\frac{3}{4}d.$ | 3. 3s. $1\frac{1}{2}d.$ |
| 4. 3·4236. | 5. 12. | 6. ·046. |
| 7. 1 qr. 16 lb. 3 oz. | 8. $2 \times 3 \times 7 \times 11 \times 13 \times 17$. | 9. 1579. |
| 10. £212. 13s. $3d.$ | | |

EXERCISE 17 (c).

- | | | |
|-----------------------------|---------------------------------|----------------------|
| 1. 257 litres. | 2. £1310. 7s. $11\frac{1}{2}d.$ | 3. 17·69472 gallons. |
| 4. £3. 4s. $6d.$ | 5. £12. 8s. $8d.$ | 6. £2. 8s. $8d.$ |
| 7. £4. 8s. $0\frac{3}{4}d.$ | 8. 9·639 kg. | 9. £12,600. |
| 10. £2. 10s. $0d.$ | | |

EXERCISE 18 (a).

- | | | |
|---------------------------------|-------------------|---------------------|
| 1. £9965. 1s. $10\frac{1}{4}d.$ | 2. £11. 5s. $0d.$ | 3. $\frac{9}{10}$. |
| 4. 37 minutes. | 5. 8s. $9d.$ | 6. $\frac{3}{4}$. |
| 7. $1\frac{4}{15}$. | 8. ·07. | 9. £3. 8s. $0d.$ |
| 10. 4625. | 11. 10s. $6d.$ | 12. 2·6. |
| 13. 48·74. | 14. 289. | 15. 160. |
| 16. 5s. $10d.$ | 17. £2. 5s. $0d.$ | 18. £117. |
| 19. £16. 18s. $7d.$ | 20. 60. | |

EXERCISE 18 (b).

- | | | | |
|-------------------------|---------------------|----------------------|-------------------|
| 1. 1716. | 2. $\frac{8}{21}$. | 3. $3\frac{4}{15}$. | 4. ·4265625. |
| 5. $\frac{3}{8}$. | 6. ·0102. | 7. 221 yd. | 8. 13 cwt. 14 lb. |
| 9. 2s. $0\frac{1}{2}d.$ | 10. 33·75. | | |

EXERCISE 18 (c).

- | | |
|--|----------------------------|
| 1. £1756. 11s. $0d.$ | 2. $1d.$ |
| 3. £1. 4s. $6d.$; 7s. $10\frac{1}{2}d.$; £2. 14s. $0d.$; £8. 13s. $6\frac{1}{2}d.$ Total £12. 19s. $11d.$ | |
| Discount £1. 6s. $0d.$ Total paid £11. 13s. $11d.$ | |
| 4. £271. 5s. $0d.$ | 5. $3\frac{7}{11}$ miles. |
| 7. 4·9375 gallons. | 8. 4501 for; 6230 against. |
| 9. $3\frac{1}{2}$ hours. | 10. £115. 4s. $0d.$ |
| | 6. 1939 dollars. |

EXERCISE 19 (a).

- | | | |
|--------------------------|-----------------------------|------------------------|
| 1. 114,946. | 2. £394. 12s. 11½ <i>d.</i> | 3. 9 cwt. 1 qr. 21 lb. |
| 4. 1 yd. 3 in. | 5. 203 half-crowns. | 6. £1. 3s. 0 <i>d.</i> |
| 7. ⅔. | 8. 2s. per lb. | 9. £·675. |
| 10. 1⅕. | 11. 2½. | 12. 44. |
| 13. 7·821. | 14. £3. 10s. 0 <i>d.</i> | 15. 1s. 10½ <i>d.</i> |
| 16. 15. | 17. 73. | 18. 8675. |
| 19. £5. 17s. 0 <i>d.</i> | 20. 7s. 0 <i>d.</i> | |

EXERCISE 19 (b).

- | | | |
|-------------|--------------------------|---------------------------|
| 1. 2785 lb. | 2. 34,263⅓. | 3. £50. 8s. 10¾ <i>d.</i> |
| 4. 1. | 5. £35. 9s. 3¾ <i>d.</i> | 6. 2½. |
| 7. ·8. | 8. ·634 cwt. | 9. 19 yd. 8 in. |
| 10. 14·08. | | |

EXERCISE 19 (c).

- | | |
|---|------------------------------------|
| 1. 400. | 2. £1. 2s. 2 <i>d.</i> per day. |
| 3. 7 tons 11 cwt. 2 qr. 9 lb. 11 oz. | 4. £12. 17s. 6 <i>d.</i> |
| 5. £1. 6s. 7 <i>d.</i> ; 13s. 7 <i>d.</i> short. | 6. £8. 10s. 9 <i>d.</i> |
| 7. 497 <i>d.</i> | |
| 8. £5. 1s. 9 <i>d.</i> ; £4. 8s. 0 <i>d.</i> ; £3. 13s. 4 <i>d.</i> ; £1. 18s. 0 <i>d.</i> ; £1. 3s. 3½ <i>d.</i> ; 6s. 0 <i>d.</i> | |
| Total: £16. 10s. 4½ <i>d.</i> | |
| 9. 71 pieces; 1·2 cm. over. | 10. Men 1008, women 540, boys 472. |

EXERCISE 20 (a).

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|--------------------------|----------------------------|-----------------------|
| 1. 154,724. | 2. £68. 17s. 10½ <i>d.</i> | 3. 19 lb. |
| 4. £2. 6s. 0 <i>d.</i> | 5. 14s. 0 <i>d.</i> | 6. 5445. |
| 7. 540. | 8. 3·94. | 9. 1¼. |
| 10. 1⅔. | 11. 19s. 0 <i>d.</i> | 12. ·03125. |
| 13. 56 half-pounds. | 14. 13. | 15. 120. |
| 16. £6. 10s. 0 <i>d.</i> | 17. ½. | 18. 18s. 7¼ <i>d.</i> |
| 19. 9 <i>d.</i> | 20. ·14. | |

EXERCISE 20 (b).

- | | | |
|---------------------------|---------------|--------------------------|
| 1. 166½. | 2. 5,630,716. | 3. 20·2986. |
| 4. £285. 4s. 0 <i>d.</i> | 5. ·714. | 6. 430·10136; 430·10136. |
| 7. ⅓. | 8. 2° or 64. | 9. ·405. |
| 10. £37. 6s. 1½ <i>d.</i> | | |

EXERCISE 20 (c).

- | | | |
|---------------------------|------------------------|----------------------------------|
| 1. ·625 %. | 2. 20 for 1s. | 3. 259 francs. |
| 4. 43,502. | 5. £4. 2s. 8 <i>d.</i> | 6. £4. 18s. 0 <i>d.</i> per cwt. |
| 7. 1 min. 9 sec. | 8. 34·56 cub. in. | 9. £280. 17s. 9 <i>d.</i> |
| 10. £583. 6s. 8 <i>d.</i> | | |

EXERCISE 21 (a).

- | | | | | |
|---------------------------------|---|-----------------------------|---------------------------------|-------------|
| 1. 5 : 8. | 2. 2 : 3. | 3. 2 : 1. | 4. 6 : 5. | 5. 4 : 1. |
| 6. 1 : 4. | 7. 20 : 1. | 8. 5 : 9. | 9. 1 : 2. | 10. 3 : 2. |
| 11. 25 : 1. | 12. 2 : 3. | 13. 1 : 2. | 14. 2 : 3. | 15. 3 : 5. |
| 16. 2 : 3. | 17. 12 : 7. | 18. 1 : 3. | 19. 1 : 5. | 20. 3 : 5. |
| 21. 2 : 3. | 22. 1 : 2. | 23. 7 : 10. | 24. 5 : 1. | 25. 15 : 2. |
| 26. 1 : 3. | 27. 11 : 41. | 28. 1 : 1. | 29. 1 : 1. | 30. 1 : 80. |
| 31. 30. | 32. 15. | 33. 1. | 34. 1. | 35. 2. |
| 36. 10. | 37. 3 <i>d.</i> ; 1 <i>s.</i> 9 <i>d.</i> | 38. 7 <i>s.</i> 1 <i>d.</i> | 39. 2 <i>s.</i> 0 <i>d.</i> | |
| 40. 3 $\frac{2}{5}$. | 41. $\frac{3}{5}$. | 42. £36. | 43. £1. 4 <i>s.</i> 9 <i>d.</i> | |
| 44. £1. 7 <i>s.</i> 0 <i>d.</i> | 45. £1. 18 <i>s.</i> 0 <i>d.</i> | 46. 37 $\frac{1}{2}$ ml. | 47. £400. | |
| 48. 25 days. | 49. $\frac{1}{3}$ full. | 50. 6 men. | | |

EXERCISE 21 (b).

- | | | | |
|---|---|---|----------------------------------|
| 1. 10 \cdot 5. | 2. 5 $\frac{5}{11}$. | 3. 7 \cdot 58. | 4. 27 $\frac{1}{5}$. |
| 5. 7 $\frac{1}{14}$. | 6. 50. | 7. 5 $\frac{2}{3}$. | 8. £1. 5 <i>s.</i> 0 <i>d.</i> |
| 9. 5 yd. | 10. 5 $\frac{1}{17}$. | 11. 8 $\frac{1}{2}$ <i>d.</i> | 12. 40 dozen. |
| 13. £2625. | 14. 9 <i>s.</i> 4 $\frac{1}{2}$ <i>d.</i> | 15. £1. 9 <i>s.</i> 3 <i>d.</i> | 16. £6. 12 <i>s.</i> 0 <i>d.</i> |
| 17. 192 cwt. | 18. 8 <i>s.</i> 9 <i>d.</i> | 19. 536; 402. | 20. 1250 litres. |
| 21. 240 toys. | 22. £1. 4 <i>s.</i> 6 <i>d.</i> | 23. £4. 17 <i>s.</i> 4 <i>d.</i> | 24. £5. 8 <i>s.</i> 0 <i>d.</i> |
| 25. 35,000 francs. | 26. 1 <i>s.</i> 2 $\frac{3}{4}$ <i>d.</i> | 27. £1950. | |
| 28. 7 <i>s.</i> 6 <i>d.</i> ; 9 <i>s.</i> 2 <i>d.</i> ; 10 <i>s.</i> 10 <i>d.</i> | 29. 22 $\frac{1}{2}$ days. | 30. £154; £33. 16 <i>s.</i> 6 <i>d.</i> | 31. £3. 18 <i>s.</i> 9 <i>d.</i> |
| 30. £154; £33. 16 <i>s.</i> 6 <i>d.</i> | 31. £3. 18 <i>s.</i> 9 <i>d.</i> | 32. 6 men. | |
| 33. 1 hr. 30 min. | 34. 72 m.p.h. | | |
| 35. £3. 10 <i>s.</i> ; £5. 5 <i>s.</i> ; £12. 5 <i>s.</i> | 36. £5. 14 <i>s.</i> 0 <i>d.</i> | 37. 18 months. | |
| 38. 8 $\frac{1}{3}$ days. | 39. 58·8 days. | 40. 74 $\frac{1}{4}$ lb. | |

EXERCISE 22 (a).

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|---|----------------------------------|----------------------------------|----------------------------------|-------------------------|
| 1. $\frac{1}{20}$. | 2. $\frac{1}{10}$. | 3. $\frac{1}{50}$. | 4. $\frac{1}{5}$. | 5. $\frac{1}{25}$. |
| 6. $\frac{1}{4}$. | 7. $\frac{1}{2}$. | 8. $\frac{1}{3}$. | 9. $\frac{2}{3}$. | 10. $\frac{3}{4}$. |
| 11. 1. | 12. 2. | 13. $\frac{1}{30}$. | 14. $\frac{1}{15}$. | 15. $\frac{1}{400}$. |
| 16. 20%. | 17. 10%. | 18. 25%. | 19. 33 $\frac{1}{3}$ %. | 20. 66 $\frac{2}{3}$ %. |
| 21. 75%. | 22. 34%. | 23. 9 $\frac{1}{2}$ %. | 24. 125%. | 25. 220%. |
| 26. 3%. | 27. 15%. | 28. 7 $\frac{1}{2}$ %. | 29. 525%. | 30. $\frac{1}{4}$ %. |
| 31. £2. 10 <i>s.</i> 0 <i>d.</i> | 32. £2. 15 <i>s.</i> 6 <i>d.</i> | 33. 12 $\frac{1}{2}$ %. | 34. 66 $\frac{2}{3}$ %. | |
| 34. 1·375%. | 35. 9 <i>d.</i> | 36. 66 $\frac{2}{3}$ %. | 37. £12. 5 <i>s.</i> 0 <i>d.</i> | |
| 37. 17 <i>s.</i> 0 <i>d.</i> | 38. £2. 5 <i>s.</i> 6 <i>d.</i> | 39. £12. 5 <i>s.</i> 0 <i>d.</i> | 40. 25%. | |
| 40. 9 <i>s.</i> 0 $\frac{1}{2}$ <i>d.</i> | 41. 20%. | 42. 25%. | 43. 40%. | |
| 43. 10%. | 44. 65%. | 45. 40%. | | |

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|-------------------------|---------------------|-------------------|
| 46. $33\frac{1}{3}\%$. | 47. $43\cdot25\%$. | 48. 35% . |
| 49. 52% . | 50. 55% . | 51. £18. 15s. 0d. |
| 52. 11s. 10d. | 53. 17,600. | 54. 90,000. |
| 55. £32. 10s. 0d. | 56. 20% . | 57. £200. |
| 58. £1000. | 59. 90% . | 60. 20% . |

EXERCISE 22 (b).

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|-------------------------|-------------------------|--------------------------|--------------------------|----------------------------|
| 1. $\frac{4}{5}\%$. | 2. $\frac{53}{125}\%$. | 3. $\frac{21}{180}\%$. | 4. $\frac{7}{320}\%$. | 5. $\frac{19}{450}\%$. |
| 6. $1\frac{1}{5}\%$. | 7. $2\frac{9}{40}\%$. | 8. $1\frac{2}{3}\%$. | 9. $\frac{21}{800}\%$. | 10. $\frac{29}{40000}\%$. |
| 11. $29\cdot2\%$. | 12. $70\frac{5}{8}\%$. | 13. $204\frac{2}{3}\%$. | 14. $92\frac{4}{13}\%$. | 15. $266\frac{2}{3}\%$. |
| 16. $102\cdot45\%$. | 17. $712\cdot85\%$. | 18. $111\frac{1}{9}\%$. | 19. 150% . | 20. $113\frac{7}{11}\%$. |
| 21. $4\frac{1}{2}\%$. | 22. £11. 8s. 0d. | 23. 36. | 24. 6s. 5d. | 25. $40\frac{1}{2}$ in. |
| 26. £10. 17s. 9d. | 27. $6\frac{3}{10}\%$. | 28. $40\frac{1}{2}$ in. | 29. $46\frac{3}{4}\%$. | 30. $45\frac{5}{8}\%$. |
| 31. $37\frac{1}{2}\%$. | 32. 15% . | 33. $46\frac{3}{4}\%$. | 34. $17\frac{1}{11}\%$. | 35. $18\frac{3}{4}\%$. |
| 36. $37\frac{1}{2}\%$. | 37. $6\frac{1}{4}\%$. | 38. 102% . | 39. $4\frac{1}{2}\%$. | |

EXERCISE 22 (c).

- | | | |
|-------------------------------|---|---------------------------------|
| 1. $36\frac{4}{11}\%$. | 2. £12. 6s. 3d. | 3. $28\frac{1}{4}\%$. |
| 4. £25. 9s. 3d. | 5. $45\frac{5}{8}\%$. | 6. £85. 17s. 6d. |
| 7. £1020. | 8. £46. 17s. 6d. | 9. £14. 8s. 9d. |
| 10. £5. 9s. 3d. | 11. $4\frac{1}{2}\%$. | 12. $28\frac{1}{4}\%$. |
| 13. $33\frac{1}{4}\%$ profit. | 14. Gain = 20% . | 15. £37. 10s. 0d. |
| 16. £6. 8s. 3d. | 17. $31\frac{1}{4}\%$ profit. | 16. £579. 13s. 9d. |
| 18. $22\frac{2}{9}\%$. | 19. £5. 8s. 4d. | 17. 19s. 6d. increase. |
| 19. $22\frac{2}{9}\%$. | 20. 15% gain. | 18. $12\frac{1}{2}\%$ gain. |
| 20. £276. | 21. 3s. 8d. | 19. £113. 8s. 0d. |
| 21. $37\frac{1}{4}\%$ gain. | 22. $15\frac{5}{8}\%$ gain. | 20. £16. 8s. $10\frac{1}{2}$ d. |
| 22. $45\frac{5}{8}\%$. | 23. $29\frac{1}{6}\%$ profit; £25. 16s. 8d. | |
| 23. £1. 4s. 6d. | 24. Loss = £14. 11s. 0d. | 21. 1200 bushels. |
| 24. £8. 17s. 1d. profit. | 25. 20% gain. | |

EXERCISE 23 (a).

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|-------------------|--------------------|------------------|---------------------------|
| 1. £10. | 2. £10. | 3. £6. 15s. 0d. | 4. £12. 10s. 0d. |
| 5. £93. 15s. 0d. | 6. £22 10s. 0d. | 7. £20. | 8. £48. |
| 9. £150. | 10. £50. | 11. £45. | 12. £150. |
| 13. £210. | 14. £157. 10s. 0d. | 15. £420. | 16. £841. |
| 17. £10. 16s. 0d. | 18. 6% . | 19. £1. 16s. 0d. | 20. £3. 7s. 6d. |
| 21. 6% . | 22. £8. 6s. 0d. | 23. £12. | 24. $3\frac{1}{2}$ years. |
| 25. 3 years. | | | |

EXERCISE 23 (b).

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|-----------------------------------|------------------------------------|
| 1. £13. 6s. 8d.; £513. 6s. 8d. | 2. £6. 11s. 3d.; £181. 11s. 3d. |
| 3. £40. 13s. 9d.; £366. 3s. 9d. | 4. £108. 17s. 3d.; £834. 12s. 3d. |
| 5. £104. 4s. 1d.; £939. 16s. 7d. | 6. £8. 16s. 8d.; £28. 9s. 2d. |
| 7. £13. 3s. 6d.; £175. 6s. 10d. | 8. £26. 18s. 8d.; £176. 11s. 2d. |
| 9. £86. 15s. 10d.; £437. 9s. 2d. | 10. £60. 17s. 9d.; £791. 11s. 0d. |
| 11. £125. 8s. 11d.; £627. 4s. 6d. | 12. £6. 1s. 8d.; £423. 1s. 8d. |
| 13. £10. 14s. 9d.; £153. 9s. 9d. | 14. £39. 6s. 11d.; £568. 6s. 11d. |
| 15. £5. 2s. 5d.; £724. 2s. 5d. | 16. £10. 1s. 11d.; £890. 11s. 11d. |
| 17. £45. 16s. 7d.; £569. 11s. 7d. | 18. £6. 19s. 9d.; £934. 5s. 9d. |
| 19. £14. 18s. 1d.; £665. 6s. 1d. | 20. £189. 3s. 5d.; £720. 3s. 5d. |
| 21. $3\frac{1}{2}$ years. | 22. $3\frac{1}{5}$ years. |
| 24. $4\frac{1}{6}$ years. | 25. $4\frac{1}{2}$ years. |
| 27. 8 years. | 28. $\frac{5}{12}$ year. |
| 30. $1\frac{4}{5}$ years. | 31. $8\frac{1}{2}\%$. |
| 33. $6\frac{1}{2}\%$. | 34. $5\frac{1}{2}\%$. |
| 36. £560. | 37. £1625. |
| 39. £279. | 40. £732. 10s. 0d. |
| 42. £1276. 13s. 4d. | 43. £255. 12s. 6d. |
| 45. £213. 10s. 6d. | 23. $4\frac{2}{5}$ years. |
| | 26. $2\frac{1}{2}$ years. |
| | 29. $\frac{8}{15}$ year. |
| | 32. $2\frac{1}{2}\%$. |
| | 35. $4\frac{1}{2}\%$. |
| | 38. £529. 5s. 9d. |
| | 41. £3550. |
| | 44. £567. |

EXERCISE 23 (c).

- | | | |
|--------------------------------|-------------------------------|-----------------------|
| 1. £104. | 2. $4\frac{1}{2}\%$. | 3. $4\frac{1}{2}\%$. |
| 4. $3\frac{7}{8}\%$. | 5. £19 14s. $4\frac{1}{2}$ d. | 6. £125. |
| 7. 250 days; Nov. 6th, 1920. | 8. £1138. | 9. £9. 7s. 6d. |
| 10. £1. 1s. 0d. | 11. $5\frac{1}{4}\%$. | 12. £1666. 13s. 4d. |
| 13. 5% ; $6\frac{1}{4}\%$. | 14. £2. 7s. 4d. | 15. £550. |
| 16. £555. 13s. 0d. | 17. £23. 19s. 0d. | 18. 17s. 9d. |

EXERCISE 24.

- | | |
|-------------------------------------|-------------------------------------|
| 1. £463. 1s. 0d.; £63. 1s. 0d. | 2. £1215. 10s. 1d.; £215. 10s. 1d. |
| 3. £5. 2s. 0d.; 2s. 0d. | 4. £590. 11s. 1d.; £65. 11s. 1d. |
| 5. £1856. 11s. 6d.; £106. 11s. 6d. | 6. £85. 4s. 2d.; £9. 9s. 2d. |
| 7. £352. 1s. 3d.; £26. 11s. 3d. | 8. £785. 19s. 11d.; £56. 2s. 5d. |
| 9. £2175. 7s. 5d.; £385. 13s. 9d. | 10. £8181. 13s. 0d.; £830. 16s. 6d. |
| 11. £5565. 15s. 2d.; £397. 0s. 7d. | 12. £9413. 8s. 4d.; £1125. 15s. 7d. |
| 13. £6633. 14s. 8d.; £735. 19s. 2d. | 14. £8534. 6s. 4d.; £548. 16s. 1d. |
| 15. £1840. 1s. 3d.; £252. 7s. 1d. | |

EXERCISE 25 (a).

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|----------------------------------|----------------------------------|--------------|-----------------|
| 1. £306. 11s. 3 $\frac{3}{4}$ d. | 2. 1 $\frac{1}{2}$. | 3. 4. | 4. £2. 13s. 8d. |
| 5. £16. 17s. 0d. | 6. £20. | 7. £4. | 8. £108. |
| 9. 1 $\frac{3}{4}$. | 10. $\frac{4}{5}$. | 11. 19s. 0d. | 12. 1.1. |
| 13. £17. 10s. 0d. | 14. 44.8 or 44 $\frac{4}{5}$ lb. | 15. £35. | 16. 25. |
| 17. .3. | 18. 60. | 19. 365. | 20. 34,680. |

EXERCISE 25 (b).

- | | | | |
|------------------|----------------------|---------------------------------|---------------------------|
| 1. 683.616. | 2. 1 $\frac{1}{9}$. | 3. £2. 13s. 10 $\frac{1}{2}$ d. | 4. £.38125. |
| 5. £5. 9s. 1d. | 6. £108. 9s. 6d. | 7. 15s. 2 $\frac{1}{4}$ d. | 8. 8s. 7 $\frac{1}{4}$ d. |
| 9. £16. 13s. 6d. | 10. £834. | | |

EXERCISE 25 (c).

- | | | |
|---|------------------|----------------------------|
| 1. 25 miles. | 2. 6 more carts. | |
| 3. £2. 6s. 0d.; £4. 13s. 0d.; £2. 6s. 8d.; £4. 2s. 6d.; £1. 13s. 4d.; £1. 3s. 6d.; 7s. 6d. Total £16. 12s. 6d. Discount 16s. 7 $\frac{1}{2}$ d. Total paid, £15. 15s. 10 $\frac{1}{2}$ d. | | |
| 4. 45 miles per hour. | 5. 33 lb. | 6. 7 $\frac{1}{2}$ % gain. |
| 7. 3 men. | 8. 72, 36, 24. | 9. £3. 2s. 6d. |
| 10. £1930. 10s. 0d. | | |

EXERCISE 26 (a).

- | | | |
|----------------------------------|-----------------------|-----------------------|
| 1. 46,189. | 2. 5.7536. | 3. 12.8. |
| 4. £2091. 2s. 2 $\frac{1}{2}$ d. | 5. £103. 10s. 11d. | 6. 11 $\frac{1}{2}$. |
| 7. 90. | 8. 2 $\frac{1}{2}$ d. | 9. £16. |
| 10. £42. 10s. 0d. | 11. £4. 17s. 11d. | 12. 7s. 6d. |
| 13. £44. 12s. 6d. | 14. £13. 15s. 0d. | 15. £91. |
| 16. 7 $\frac{1}{2}$ %. | 17. 5.5 francs. | 18. £14. 14s. 0d. |
| 19. 20%. | 20. 34 books. | |

EXERCISE 26 (b).

- | | | |
|---|-----------------------|------------------|
| 1. $\frac{3}{14}$. | 2. 2.5. | 3. 23 cwt. |
| 4. £9. 4s. 5d. | 5. £37,823. 15s. 10d. | 6. 164 litres. |
| 7. 91 pieces; 3 $\frac{3}{8}$ in. over. | 8. 78 men. | 9. £563. 7s. 9d. |
| 10. £64. 15s. 0d. | | |

EXERCISE 26 (c).

- | | | |
|------------------------------------|------------------------|------------------|
| 1. 142 grams. | 2. 77.8 sec. | 3. £8880. |
| 4. 55 $\frac{9}{135}$. | 5. 19%. | 6. £750. |
| 7. 130,280. | 8. 56 $\frac{1}{4}$ %. | 9. £14. 19s. 3d. |
| 10. A. £3. 5s. 0d.; B. £4. 7s. 9d. | | |

EXERCISE 27 (a).

- | | | |
|------------------|-------------------------------------|--------------------------|
| 1. 1452. | 2. £102,215. 18s. $1\frac{1}{2}d$. | 3. 8 days 14 hr. 30 min. |
| 4. 71 min. | 5. 883. | 6. £2. 8s. 0d. |
| 7. 75 %. | 8. $5^{\circ}/_{\circ}$. | 9. 2s. 10d. |
| 10. 4.48. | 11. 70. | 12. 19,075. |
| 13. £7. 10s. 0d. | 14. 10. | 15. 3.5. |
| 16. 19s. 3d. | 17. £17. 5s. 0d. | 18. £2. 5s. 0d. |
| 19. 4s. 10d. | 20. £5. 16s. 0d. | |

EXERCISE 27 (b).

- | | | |
|-----------------------|---------------|-------------------|
| 1. $\frac{45}{143}$. | 2. 379.08. | 3. £99. 8s. 6d. |
| 4. £16. 8s. 0d. | 5. 70,479.29. | 6. £19. 8s. 8d. |
| 7. £183. 1s. 5.4d. | 8. 17 men. | 9. 5 francs 18 c. |
| 10. £131. 5s. 0d. | | |

EXERCISE 27 (c).

- | | | |
|---------------------------------------|---|----------------|
| 1. $4\frac{1}{2}^{\circ}/_{\circ}$. | 2. 960, 1440, 2400, 2880. | 3. £3620. |
| 4. £68. 8s. 0d. | 5. Actual Interest £55; $4\% = £55.2$. | |
| 6. $49\frac{1}{3}^{\circ}/_{\circ}$. | 7. 500 packets. | 8. £9. 9s. 0d. |
| 9. £3. 6s. 0d. | 10. 15s. 2d. | |

EXERCISE 28 (a).

- | | | |
|----------------------|---------------------|----------------------------------|
| 1. 447.0057. | 2. 30,850. | 3. 23,470. |
| 4. 170. | 5. 40.4. | 6. £2167. 10s. $9\frac{1}{2}d$. |
| 7. 60. | 8. $4\frac{1}{8}$. | 9. $2\frac{5}{7}$. |
| 10. $1\frac{1}{3}$. | 11. 90. | 12. 144 pencils. |
| 13. 20 francs. | 14. £14. 8s. 0d. | 15. 9d. |
| 16. .05. | 17. £3. 10s. 0d. | 18. 7s. 6d. |
| 19. 11s. 3d. | 20. £5. 10s. 6d. | |

EXERCISE 28 (b).

- | | | |
|--|-----------------------|---------------------|
| 1. $\frac{484}{1887}$. | 2. $3\frac{17}{22}$. | 3. .882. |
| 4. 670.10272; 670,102.72; .067010272; 67.010272. | | |
| 5. £64. 19s. $4\frac{1}{2}d$. | 6. £8. 2s. 6d. | 7. $\frac{1}{2}d$. |
| 8. £10. 3s. 0d. | 9. £1568. 17s. 6d. | 10. £8750. |

EXERCISE 28 (c).

- | | | |
|--|---------------------------|----------------|
| 1. 2s. 9d. per pair. | 2. $\frac{1}{8}$ saved. | 3. £3. 3s. 0d. |
| 4. 45 miles per hour. | 5. 1s. $10\frac{1}{2}d$. | 6. £456. |
| 7. $38\frac{4}{17}^{\circ}/_{\circ}$. | 8. £127. 15s. 5d. | 9. 17.025 kg. |
| 10. £7. 10s. 0d. | | |

EXERCISE 29 (a).

- | | | |
|---|-----------------|-----------------|
| 1. 80 sq. in. | 2. 36 sq. in. | 3. 14 sq. ft. |
| 4. $21\frac{1}{4}$ sq. ft. | 5. 180 sq. in. | 6. 11 sq. ft. |
| 7. 2 sq. yd. | 8. 1000 sq. cm. | 9. 17 sq. m. |
| 10. 13 sq. m. | 11. 6 ft. 8 in. | 12. 10 in. |
| 13. 3 ft. 6 in. | 14. 6 yd. | 15. 50 metres. |
| 16. (a) 4840 sq. yd., (b) 1210 sq. yd., (c) 444 sq. yd. | | |
| 17. (a) 36 sq. in., (b) 180 sq. in., (c) 14,400 sq. in. | | |
| 18. 484 sq. yd. | 19. 8s. 9d. | 20. 1·8 sq. in. |
| 21. $110\frac{1}{4}$ sq. ft. | 22. 43 ft. | 23. 18 sq. ft. |
| 24. £1. 15s. 0d. | 25. 33 ft. | |

EXERCISE 29 (b).

- | | |
|---|--|
| 1. 168 sq. yd. | 2. $1\frac{7}{8}$ sq. yd. or 1 sq. yd. 7 sq. ft. 126 sq. in. |
| 3. $951\frac{1}{2}$ sq. ft. | 4. 3·403125 sq. ft. |
| 5. 830 acres 3740 sq. yd. | 6. 9 sq. cm. |
| 7. 8 sq. miles 54 acres. | 8. 7022·4 sq. metres. |
| 9. 8·15 ft. | 10. 29 yd. or 87 ft. |
| 11. $23\frac{1}{3}$ yd. or 23 yd. 1 ft. | 12. 11 m. 23 cm. |
| 13. £75. | 14. £18. 6s. 8d. |
| 15. £200. 2s. 0d. | 16. £31. 2s. 8½d. |
| 17. £8. 2s. 10d. (nearest penny). | 18. £5. 3s. 11·4d. |
| 19. £43,560. | 20. £28. 9s. 6⅓d. |

EXERCISE 29 (c).

- | | |
|------------------------|----------------------------------|
| 1. 6½d. | 2. 352; £2. 10s. 0d. for labour. |
| 3. £50. | 4. £37. 10s. 0d. |
| 6. 12,600; £9. 9s. 0d. | 5. 305 yd. |
| 8. £18. | 7. $870\frac{5}{2}$ sq. yd. |
| | 9. 46·53 sq. metres. |
| 11. 216 francs. | 10. 2940 francs. |
| 12. 3 m. 46 cm. | 13. 78 sq. ft. |
| 14. 3402 tiles. | 15. 1½ chains. |
| | 16. £8. 11s. 0d. |

EXERCISE 30 (a).

| No. | Ceiling. | Long Wall. | Short Wall. |
|-----|-------------|-------------|-------------------|
| 1. | 120 sq. ft. | 120 sq. ft. | 100 sq. ft. |
| 2. | 192 " | 160 " | 120 " |
| 3. | 300 " | 250 " | 120 " |
| 4. | 375 " | 225 " | 135 " |
| 5. | 165 " | 165 " | 100 " |
| 6. | 222 " | 144 " | $98\frac{2}{3}$ " |
| 7. | 164 " | 144 " | $92\frac{1}{4}$ " |
| 8. | 192 " | 152 " | 114 " |
| 9. | 180 sq. m. | 135 sq. m. | 108 sq. m. |
| 10. | 200 " | 128 " | 100 " |

- | | | |
|-------------------------|------------------------------------|-----------------|
| 11. 440 sq. ft. | 12. 222 sq. ft. left of long wall. | 13. 205 sq. ft. |
| 14. No. 6; £1. 17s. 0d. | 15. 28 sq. ft. | 16. 4 sq. in. |
| 17. 32 sq. in. | 18. 24 sq. in. | 19. 168 sq. in. |
| 21. 32 sq. in. | 22. 280 sq. ft. | 23. 160 sq. ft. |
| 25. 24 yd. | 26. 12 stone. | 27. 2 strips. |
| | | 28. 480 tiles. |

EXERCISE 30 (b).

- | | | |
|-----------------------------|------------------------------|----------------------|
| 1. 800 sq. ft. | 2. 476 sq. ft. | 3. 74 sq. yd. |
| 4. 510 sq. ft. 18 sq. in. | 5. 572 sq. ft. | 6. 372 sq. ft. |
| 7. 45.02 sq. in. | 8. $53\frac{7}{9}$ sq. ft. | 9. 25.2395 sq. in. |
| 10. $56\frac{1}{4}$ sq. ft. | 11. $347\frac{1}{2}$ sq. ft. | 12. £33. 1s. 4d. |
| 13. £3. 3s. 4d. | 14. £3. 11s. 8d. | 15. 14s. 2d. nearly. |

EXERCISE 30 (c).

- | | | |
|--|--------------------------------|-----------------------|
| 1. 36 yd. | 2. 10 ft. 6 in. | 3. £1. 8s. 0d. |
| 4. 25 yd.; 75 yd. | 5. £16. 4s. 0d. | 6. 10 times. |
| 7. 101 sq. yd. | 8. $88\frac{1}{4}$ sq. ft. | 9. $3\frac{1}{4}$ in. |
| 10. 588 sq. ft. | 11. $5\frac{1}{16}$ sq. miles. | 12. 3375 sq. ft. |
| 13. 288 tiles. | 14. £1. 5s. 0d. | |
| 15. £13. 4s. 0d.; £11. 2s. 0d.; Total £24. 6s. 0d. | 16. 1.0176 sq. metres. | |
| 17. £19. 4s. 0d. | 18. £2. 2s. 6d. | |
| 19. 10 in. to 1 mile; 440 yd.; 88 yd. | 20. 6d. per sq. ft. | |
| 21. £35. | 22. 3928 sq. ft. | 23. 48 grams. |
| | 24. £1. 3s. 10d. | |

EXERCISE 31 (a).

- | | | |
|------------------|-----------------------------|--------------------|
| 1. 120 cub. in. | 2. 160 cub. in. | 3. 72 cub. ft. |
| 4. 25 cub. ft. | 5. 46 c.c. | 6. 780 c.mm. |
| 7. 56 cub. yd. | 8. $33\frac{1}{4}$ cub. in. | 9. 4 cub. ft. |
| 10. 378 cub. yd. | 11. 512 cub. in. | 12. 3 yd. |
| 13. 6 in. | 14. 700 cub. ft. | 15. 3.2 c. metres. |
| 16. 1600 sq. in. | 17. 288 blocks. | 18. 32 cub. in. |
| 19. 6060 oz. | 20. £10. 2s. 6d. | |

EXERCISE 31 (b).

- | | | |
|------------------------------|-----------------------------|-------------------------------|
| 1. 44 cub. ft. 1584 cub. in. | 2. $4\frac{2}{3}$ cub. in. | 3. 18 cub. ft. 816 cub. in. |
| 4. 98 cub. ft. 756 cub. in. | 5. 1.398 cub. in. | 6. 3375.5 c. c. |
| 7. 906 c.c. | 8. 20.357 cub. in. | 9. $21\frac{33}{64}$ cub. in. |
| 10. 812.16 cub. in. | 11. $18\frac{1}{4}$ sq. ft. | 12. $3\frac{8}{9}$ sq. ft. |
| 13. 9.322 sq. in. | 14. 3782.5 sq. cm. | 15. 12.615 sq. in. |
| 16. 11.731 sq. in. | 17. 3.03 in. | 18. $4\frac{1}{2}$ in. |
| 19. $b = \frac{V}{lh}$. | 20. $11\frac{1}{2}$. | |

EXERCISE 31 (c).

- | | | | |
|--|------------------------|------------------------------------|----------|
| 1. $8\frac{1}{3}d.$ | 2. $8\frac{8}{35}$ ft. | 3. 2 ft. | 4. 4480. |
| 5. $15\frac{1}{6}\frac{1}{2}$ cub. ft. ; 17 cub. ft. | | 6. 1723·8. | |
| 7. 873 kg. | | 8. 89 c.c. | |
| 9. 25 tons. | | 10. £5, 10s. 0d. | |
| 11. 490 yd. | | 12. 1,520,640 bricks. | |
| 13. 10 ft. 6 in. | | 14. 375 gallons. | |
| 15. 2304 boards. | | 16. $10\frac{1}{8}\frac{5}{8}$ lb. | |
| 17. 27 sq. ft. | | 18. 256 blocks. | |
| 19. 63,360 cub. ft. per min. | | 20. 1 ft. 9 in. | |

EXERCISE 32 (a).

- | a. | b. | |
|--|---|------------------------------------|
| 1. πr^2 . | $\pi \times 5^2$ sq. in. | $78\frac{1}{2}$ sq. in. |
| 2. $\pi \frac{D^2}{4}$. | $\pi \times \frac{7^2}{4}$ sq. in. | $38\frac{1}{2}$ sq. in. |
| 3. $\sqrt{\frac{A}{\pi}}$. | $\sqrt{\frac{18}{\pi}}$ in. | 2·4 in. |
| 4. $2\sqrt{\frac{A}{\pi}}$. | $2\sqrt{\frac{250}{\pi}}$ cm. | 17·8 cm. |
| 5. $\frac{1}{2}\pi r^2$. | $\frac{1}{2}\pi \times (17)^2$ sq. ft. | $454\frac{1}{2}$ sq. ft. |
| 6. $\frac{1}{8}\pi D^2$. | $\frac{1}{8}\pi \times (15)^2$ sq. in. | $88\frac{1}{2}\frac{1}{3}$ sq. in. |
| 7. $2\pi r$. | 16 π in. | $50\frac{2}{3}$ in. |
| 8. $\frac{1}{2}\pi D$. | $\frac{1}{2}\pi \times 3\cdot7$ in. | 5·8 in. |
| 9. $\frac{c}{\pi}$. | $\frac{25\cdot3}{\pi}$ in. | 8·05 in. |
| 10. $\frac{4}{3}\pi r^3$. | $\frac{4}{3}\pi \times (2)^3$ cub. in. | 33·5 cub. in. |
| 11. $\frac{1}{6}\pi D^3$. | $\frac{1}{6}\pi \times (2\cdot3)^3$ cub. ft. | 6·4 cub. ft. |
| 12. $\sqrt[3]{\frac{3V}{4\pi}}$. | $\sqrt[3]{\frac{3 \times 4851}{4\pi}}$ ft. | 10 ft. 6 in. |
| 13. $2\sqrt[3]{\frac{3V}{4\pi}}$. | $2\sqrt[3]{\frac{3 \times 3\frac{7}{8}}{4\pi}}$. | $11\frac{9}{11}$ ft. |
| 14. $\pi r^2 h$. | $\pi \times (7)^2 \times 9$ cub. in. | 1386 cub in. |
| 15. $\frac{1}{3}\pi r^2 h$. | $\frac{1}{3}\pi (3)^2 \times 6$ cub. in. | $56\frac{2}{3}$ cub. ft. |
| 16. $2\pi r h$. | $2\pi \times 6 \times 12$ sq. cm. | $452\frac{2}{3}$ sq. cm. |
| 17. $\pi r l$. | $\pi \times 5 \times 7$ sq. in. | 110 sq. in. |
| 18. $4\pi r^2$. | $4\pi \times (5\cdot3)^2$ sq. in. | 353 sq. in. |
| 19. $3\pi r^2$. | $3\pi \times (3)^2$ sq. in. | $84\frac{2}{3}$ sq. in. |
| 20. $\pi r^2 h + \frac{2}{3}\pi r^3$. | $\pi (3\cdot5)^2 \times 9\cdot8 + \frac{2}{3}\pi \times (3\cdot5)^3$ cub. ft. | 467 cub. ft. |

EXERCISE 32 (b).

EXERCISE 32 (c).

- | | | |
|---|------------------------|-----------------------------|
| 1. $269\frac{1}{2}$ cub. in. | 2. $49\frac{1}{2}$ lb. | 3. 6000 times. |
| 4. 6.06 lb. | 5. 72,600 tons. | 6. $84\frac{7}{8}$ sq. in. |
| 7. $81\frac{7}{8}$ bushels; $3273\frac{1}{2}$ lb. | 8. 85 tins. | 9. 1386 sq. ft. |
| 10. $502\frac{7}{8}$ acres. | 11. 9s. 9d. | 12. 197,400. |
| 13. 2.82 cm. | 14. 1,108,800 litres. | 15. $174\frac{3}{8}$ hours. |
| 16. 17 lb. | 17. 1772 cub. ft. | 18. 1061 loads. |
| 19. $2\frac{1}{2}$ in. | 20. 891 lb. | |

EXERCISE 33.

- | | | |
|--|-------------------------------|-------------------------------|
| 1. 383.32 cub. dm. | 2. 375 sq. in. ; 160 in. | 3. $111\frac{1}{4}$ cub. ft. |
| 4. 98 minutes. | 5. 611 tiles. | 6. £1089. |
| 7. 178 cm. | 8. 2.5 mm. | 9. 68.445 kg. |
| 10. 161 lb. | 11. £2. 10s. 0d. nearly. | 12. .10 in. |
| 13. 546 lb. | 14. £4. | 15. 8755 tons. |
| 16. 286 ft.; $193\frac{5}{8}$ cub. ft. | 17. 24.8 ft. | 18. 2 ft. 4 in. |
| 19. .72 kg. | 20. 22 yd. | 21. 10 gallons. |
| 22. 9 yd. | 23. $513\frac{1}{3}$ cub. ft. | 24. $949\frac{2}{3}$ cub. ft. |

EXERCISE 34 (a).

- | | | |
|------------------------------|----------------------------------|---------------------------|
| 1. 17s. 7d. | 2. £4.979. | 3. 17s. $6\frac{1}{3}$ d. |
| 4. £14. 14s. 0d. | 5. £262. 10s. 0d. | 6. 4s. 7d. |
| 7. 8613. | 8. 144. | 9. 4. |
| 10. $3\frac{8}{15}$. | 11. .4. | 12. £12. |
| 13. 2.937. | 14. .035. | 15. 250 sq. ft. |
| 16. $3\frac{1}{2}$; 3.1416. | 17. £1350, £810, £540. | 18. £760. |
| 19. 4.08. | 20. $7\frac{1}{2}$ d. per dozen. | |

EXERCISE 34 (b).

- | | | |
|------------------------|------------------------------------|-------------------------------------|
| 1. .71. | 2. 112.5. | 3. £92. 13s. 3d. |
| 4. $\frac{35}{9}$. | 5. £5. 19s. 7d. | 6. $25\frac{1}{2}$ sq. in. ; 37 in. |
| 7. $74\frac{1}{4}$ lb. | 8. £288,572. 9s. $7\frac{1}{8}$ d. | 9. 1100 sq. in. |
| 10. £1. 8s. 5d. | | |

EXERCISE 34 (c).

- | | |
|------------------------|-------------------------------|
| 1. .063 in. ; .160 cm. | 2. £84,350, £65,070, £53,020. |
| 3. £900. | 4. £19. |
| 5. £2355. | 6. 3. |
| 7. 5.346 km. | 8. £2400. |
| 9. $1\frac{1}{2}$ cm. | 10. $7\frac{3}{4}$ days. |

EXERCISE 34 (a).

1. 307 million, two hundred and sixty thousand and eight.
2. £1. 13s. 0d.
3. £226. 12s. 11d.
4. 75,000.
5. 102.
6. £2. 5s. 0d.
7. 53; 57.
8. 03.
9. £21.
10. $\frac{1}{8}$.
11. 3 or $\frac{3}{10}$.
12. £5890.
13. 288.
14. 8.55 in.
15. $(2\pi \times (2.25)^2 + \pi \times 2.25 \times 15)$ sq. cm.
16. £31. 10s. 0d.
17. 11s. 3d.
18. $33\frac{1}{2}\%$; 25% .
19. £1000.
20. 90 miles per hour.

EXERCISE 35 (b).

1. 7.768.
2. 1470.330576.
3. £81. 10s. 9d.
4. £183. 1s. $5\frac{2}{5}$ d.
5. £3. 2s. $6\frac{3}{4}$ d.
6. $31\frac{1}{2}$.
7. 36 hr. 15 min.
8. 8s. $3\frac{3}{4}$ d.
9. 144 packets.
10. 13s. 4d.

EXERCISE 35 (c).

1. 73 ft. per sec.
2. £386. 5s. 0d.
3. £13. 11s. 3d.
4. 2 lb.
5. 200 rupees.
6. £2. 17s. 2d.
7. 801 pieces.
8. About 11s.; £113.
9. $46\frac{2}{3}$ lb.
10. $7\frac{1}{2}$ d. per dozen.

EXERCISE 36 (a).

1. £1. 10s. 0d.
2. 7s. 9d.
3. 2s. $2\frac{1}{4}$ d.
4. 20 oz.
5. £3. 16s. 8d.
6. 7s. 0d.
7. £1. 5s. 0d.
8. 60.
9. 12.0; 15.5.
10. 5.
11. $\frac{1}{2}$ cub. ft.
12. 4d.
13. $21\frac{1}{4}\%$.
14. 92 francs.
15. 76.
16. 251,006.
17. 19.
18. £6. 5s. 0d.
19. 3000 lb.
20. 1.

EXERCISE 36 (b).

1. $3\frac{7}{8}$.
2. 156.
3. 13s. $10\frac{1}{2}$ d.
4. £7. 14s. 0d.
5. 2s. $10\frac{1}{2}$ d.
6. 86 yd.
7. £555. 16s. 2d.
8. £134,172. 10s. 0d.
9. 619 fr. 94 c.
10. 154 ft. per sec.

EXERCISE 36 (c).

1. 4057.
2. £306. 3s. $1\frac{1}{2}$ d.
3. 45 lengths; 28.35 in.
4. 35 mm.
5. $1\frac{1}{10}$ sq. in.
6. £3. 12s. 0d.
7. £38. 6s. 8d.
8. $5\frac{5}{14}\%$.
9. 4 min. 50 sec.
10. April 1.

EXERCISE 37 (a).

- | | | |
|----------------------|--------------------------------|-------------------------------|
| 1. 1·0316. | 2. £27. | 3. 25 %. |
| 4. 3s. 8d. | 5. £21. 15s. 0d.; £17. 5s. 0d. | 6. £116. 10s. 3d. |
| 7. 4 $\frac{3}{8}$. | 8. 5s. 3d. | 9. 52. |
| 10. £28. | 11. 64. | 12. $\frac{4}{3}\pi$ cub. in. |
| 13. 5 %. | 14. 9900. | 15. 10·4. |
| 16. 39 sq. ft. | 17. 50. | 18. 16s. 3d. |
| 19. ·259. | 20. 2 $\frac{5}{6}$; 3. | |

EXERCISE 37 (b).

- | | | |
|-------------------------------|--------------------------------------|-----------------------|
| 1. ·74. | 2. $\frac{1}{2}$. | 3. £20. 15s. 0d. |
| 4. 390 sq. m. | 5. H.C.F. = 6; L.C.M. = 14,040. | |
| 6. £113. 0s. 3d. | 7. 2 cwt. 3 qr. 24 $\frac{8}{9}$ lb. | |
| 8. £1. 4s. 9 $\frac{3}{4}$ d. | 9. £32. 2s. 1d. | 10. 8s. per kilogram. |

EXERCISE 37 (c).

- | | | |
|----------------------------------|--------------------------------------|---------------------------|
| 1. 7 $\frac{1}{2}$ %. | 2. 8 lb. 7 oz. | 3. 92 $\frac{1}{4}$ %. |
| 4. 8 $\frac{1}{2}$ d. | 5. 18 miles from A; 14 miles from B. | 6. 2s. 7 $\frac{1}{2}$ d. |
| 7. 11 sheets; 2 yd. 25 in. over. | | 8. 26 %. |
| 9. £8. 6s. 9d. | | 10. £30,000. |

E.M.E.U.

Central Schools' Examination, 1927.

1. (a) 1 $\frac{1}{8}$ in.; (b) $\frac{7}{160}$ lb.; (c) 2030 $\frac{8}{47}$; (d) $\frac{17}{150}$; (e) ·006; (f) ·009;
 (g) ·0345; (h) $\frac{21}{32}$ sq. in.; (i) £2. 15s. 8d. (j) £89375.
2. 4s. 8d.; 6s. 5d.; 2s. 9d.; 4s. 7d.; 2s. 7d. Total £1. 1s. 0d. (a) Change
 10. (b) 47 $\frac{1}{2}$ %.
3. £42. 16s. 4d. 4. (a) £1. 17s. 7d. per ton; (b) £175 collected.
5. 509·03 metres; 106·38727 kg. 6. 2 $\frac{1}{2}$ ft. or 30 in.
7. 5s. 4d. left; cost of hat 8s. 0d. 8. $\frac{209}{105}$ lb. 9. 3 % gained.

ROYAL SOCIETY OF ARTS.

Junior School Commercial Certificate, 1927.

Part I.

1. Across: £550. 4s. 8d.; £4674. 1s. 8d.; £3378. 8s. 10d.; £146. 18s. 8d.;
 £1292. 19s. 6d.; £1770. 13s. 5d.; £4797. 18s. 3d.; £1·69. 4s. 0d.;
 £9585. 12s. 8d.; £861. 10s. 1d.; £667. 19s. 8d.; £1159. 4s. 6d.

Down: £9731. 13s. 9d.; £19,475. 4s. 1d.; £1747. 18s. 1d.

Total £30,954. 15s. 11d.

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|----------------------------------|----------------------------|
| 2. (a) 16s. 6d.; (b) £5. 9s. 8d. | 3. (a) £3·329; (b) £5·392. |
| 4. £21. 2s. 0d. | 5. 13s. 1 $\frac{1}{2}$ d. |
| 6. £1. 6s. 8d. | 7. ·0000602. |

